PB-242 094

CONSULTANT REPORT ON MANUFACTURABILITY AND COSTS OF PROPOSED LOW-EMISSIONS AUTOMOTIVE ENGINE SYSTEMS

NATIONAL RESEARCH COUNCIL

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

NOVEMBER 1974

DISTRIBUTED BY:
NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE

164034

PB 242 094

MANUFACTURABILITY AND COSTS OF PROPOSED LOW-EMISSIONS AUTOMOTIVE ENGINE SYSTEMS

CONSULTANT REPORT TO THE:
Committee on Motor Vehicle Emissions
Commission on Sociotechnical Systems
National Research Council

SEPTEMBER 1974

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Mobile Source Air Pollution Control

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

PB242094

BIBLIOGRAPHIC DATA SHEET	1. Report No.	2.	3. Recipient's Accession No.

4. Title and Subtitle

Consultant Report on Manufacturability and Costs of Proposed Low-Emissions Automotive Engine Systems

5. Report Date

November 1974

6.

7. Author(s) L.H. Lindgren, M. Ebner, H.A. Gay, W.A. Johnson, J. Kittrell, C.R.Maxwell

8. Performing Organization Rept. No.

9. Performing Organization Name and Address

Committee on Motor Vehicle Emissions
Commission on Sociotechnical Systems
National Research Council
2101 Constitution Avenue, N.W., Washington, DC 20418

10. Project/Task/Work Unit No.

11. Contract/Grant No.

68-01-0402

12. Sponsoring Organization Name and Address

Mobile Source Air Pollution Control
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

13. Type of Report & Period Covered

14.

15. Supplementary Notes

Reproduced from best available copy.

16. Abstracts

An assessment was made of the capability of the U.S. automotive industry to produce a variety of emissions control technology for internal combustion engines and to compare the associated fuel, maintenance, sticker price and investment-cost penalties to the driving public.

17. Key Words and Document Analysis. 17a. Descriptors

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

PRICES SUBJECT TO CHANGE

18. Availability Statement Unlimited availability from NTIS for sale to public	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 328
	20. Security Class (This Page UNCLASSIFIED	22. Price 950/2.25

i.

CONSULTANT REPORT

to the

Committee on Motor Vehicle Emissions

Commission on Sociotechnical Systems

National Research Council

on

MANUFACTURABILITY AND COSTS OF PROPOSED LOW-EMISSIONS AUTOMOTIVE ENGINE SYSTEMS

PREPARED BY:

LeRoy H. Lindgren, Chairman

Merrill Ebner, Consultant Editor

Hayward A. Gay

William A. Johnson

James Kittrell

Carl R. Maxwell

Washington, D.C.

November 1974

NOTICE

This consultant report was prepared by a Panel of Consultants at the request of the Committee on Motor Vehicle Emissions of the National Academy of Sciences. Any opinions or conclusions in this consultant report are those of the Panel members and do not necessarily reflect those of the Committee or of the National Academy of Sciences.

This consultant report has not gone through the Academy review procedure. A preliminary version was reviewed by the Committee on Motor Vehicle Emissions to determine its suitability as a partial basis for the report by the Committee. The final version was received too late to be reviewed again before making it available in this published form.

The findings of the Committee on Motor Vehicle Emissions, based in part upon material in this consultant report but not solely dependent upon it, are found only in the Report by the Committee on Motor Vehicle Emissions of November 1974.

PREFACE

The National Academy of Sciences, through its Committee on Motor Vehicle Emissions (CMVE), initiated a study of automobile emissions-control technologies at the request of the United States Congress and the Environmental Protection Agency (EPA) in October 1973. To help carry out its work, the CMVE engaged panels of consultants to collect information and to prepare consultant reports on various facets of motor vehicle emissions control. This Consultant Report on Manufacturability and Costs of Proposed Low-Emissions Automotive Engine Systems is one of five consultant reports prepared and submitted to the Committee in connection with the Report by the Committee on Motor Vehicle Emissions of November 1974. The other consultant reports are:

> An Evaluation of Catalytic Converters for Control of Automobile Exhaust Pollutants, September 1974
>
> Emissions and Fuel Economy Test Methods and Procedures, September 1974
>
> Emissions Control of Engine Systems, September 1974
>
> Field Performance of Emissions-Controlled Automobiles, November 1974

These five consultant reports are NOT reports of the National Academy of Sciences or its Committee on Motor Vehicle Emissions. They have been developed for the purpose of providing a partial basis for the report by the Committee as described more fully in the cover NOTICE.

ACKNOWLEDGEMENTS

The Panel of Consultants would like to thank the following individuals for their significant contributions to this consultant report:

Donald N. Dewees -- for analyzing the Panel of Consultants' data discussed in Sections 3, 4 and 5 of this consultant report;

Glenn Bresnahan, Gene Goldstein, James Ritteman and Wahid Sheik, Boston University graduate students -- for assisting in the computerization of the calculations used in Appendices F, G, K, M and N;

Bette Bholke, Leslie Coleman and Claudia Chalifour -- for typing the final draft.

Staff members of the Committee on Motor Vehicle Emissions were also of valuable assistance in the overall preparation of this report. A special thanks to:

Emerson W. Pugh -- for his many contributions as Executive Director of the Committee;

Earl W. Evans -- for his technical assistance;

Kay Harris and Patricia McDevitt -- for their editorial work and supervision of the final typing of the manuscript;

Anne Brown -- for assistance in typing the final manuscript and for distribution of the report.

CONTENTS

1. Introduction 1

2. Industry Activity Through 1974 3

3. Vehicle Configurations Considered 10

4. Scenarios Considered 16

5. Single-Car Comparisons and Yearly Costs for Various Scenarios 32

6. Investment Costs for Various Scenarios 61

7. Development, Tooling, and Manufacturing Constraints 72

8. Comments on Alternative Industry Strategies 84

9. Summary of Findings 88

APPENDICES

A. Schedule of the Panel of Consultants on Manufacturability and Costs 93

B. Summary of Industry Answers to Panel of Consultants Questionnaire 98

C. Vehicle Structure in the Configuration File 102

D. Tooling Constraints in the Automotive Industry 111

E. Manufacturing Assessment of Alternative-Engine Technologies 132

F. Assumptions for Scenarios and Detailed Time-Phased Plans 154

G. Methodology for Summarizing Yearly Operating Costs 200

H. Automotive Fuel Cost and Availability 206

I. Vehicle Fuel-Economy Data 222

J. Vehicle Maintenance Data 230

K. Sticker List Price Data 235

L. Methodology for Calculating Investment Costs for Alternate Scenarios 243

M. Summary of Investment Cost Data 251

N. Summary of Yearly Vehicle Operating Costs 295

TABLES

Table	Title	Page
2-1	Emissions-related Investments by U.S. Automobile Companies	5
3-1	Definition of the Seven Vehicle Sizes in Each Vehicle Class	11
3-2	Vehicle Classes Available in the Current Study	13
4-1	Projected New-Car Sales in the United States, 1970-1985	17
4-2	Percentage of Annual Domestic Production for Domestic Sales by Vehicle Size: Normal Scenario	19
4-3	Percentage of Imported Cars	21
4-4	Percentage of Annual Production for Domestic Sales by Vehicle Size: Small-Car Pattern	22
4-5	Emissions Standards for Scenarios	27
4-6	Timing of Standards in Scenarios	28
5-1	Single-Car Costs of Standards on Schedule	33
5-2	Costs of Standards on Schedule, Other Studies	35
5-3	Single-Car Costs of Various Standards in 1980-85	39
5-4	Single-Car Costs of Delaying Standards	42
5-5	Total Scenario Cost of Various Standards, Scenarios A-3, J	44
5-6	1985 Scenario Costs of Various Standards, Scenarios A-E, J	47
5-7	Scenario Savings From Delaying Standards, Scenarios I, J, K	49
5-8	Single-Car Costs of Alternative Technologies	52
5-9	Scenario Costs of Alternative Technologies, Scenarios ESC, ED, EW	55

5-10 Study of Reduction in Emissions-Control Costs for Small Cars 59

5-11 Scenarios Costs of Small-Car Strategy, Scenarios C, J 60

6-1 Comparison of Scenario Investment Costs per Car for the Dominant Technology To Meet Progressive Standards 63

6-2 Comparison of Scenario Investment Costs per Car for a Conventional Engine, Dual-Catalyst, (All Vehicles are Intermediate-A Cars Which Meet the US78 Emissions Standards.) 64

6-3 Comparison of the Investment Costs per Vehicle for Alternative Technologies To Meet the T277 Standard (1.0 g/mi NO_x) 66

6-4 Comparison of Scenario Investments Costs per Car for Wankel Vehicles to Two Different Emissions Standards 68

6-5 Yearly Investment in New Manufacturing Facilities for Scenarios E, F1, J, and JSV (Incremental Investment Over Scenario A) 69

6-6 Yearly Investment in New Manufacturing Facilities for Alternative Technologies To Meet I77 Standards . . . 71

7-1 Effect of Shift to Small Vehicles and Progressive Emissions Standards on Sales by U.S. Dealers of Domestic Production 73

7-2 Estimated Capacity of the U.S. Automotive Tooling Industry in 1974 78

7-3 Emissions-Related Investment by the U.S. Automotive Industry 1970-1974 79

7-4 Combinations of Engine Technologies and Standards Studied 80

7-5 Annual Investment Costs of Meeting Various Emissions Standards Under the Assumption of Table 7-4 . 82

8-1 Effect of Shift to Small Vehicles and Progressive Emissions Standards on Sales by U.S. Dealers of Domestic Production 85

B1 Emission Systems Sticker Price Increases Over 1974 Carbureted Piston Engine Vehicles with Catalyst Subsystems. 101

C1 Engine Classification System 107

C2 Detailed Scheme for Defining CMVE Car Classes. . . . 108

C3 Details of the Significant Part Numbering System . . 109

D1 Survey of the Automotive Tooling Industry. 120

D2 Estimated Capacity of the U.S. Automotive Tooling Industry in 1974 in Millions of Dollars. 121

D3 Comparative Costs of Metal-Cutting Transfer Lines to Make Various Types of Car 126

E1 Typical Component Sticker Price Used in Developing Vehicle Costs. 142

E2 Impact of a Conversion of a Conventional 1974 Engine Complex to Various Alternative Engine Systems. 152

E3 Impact of Conversion of a Conventional 1974 Engine Complex to a Wankel Engine 153

F1 List of Scenarios for This Study 155

F2 Comparison of Car Shipments, Sales, and Registrations for 1970-1973. 157

F3 New Car Sales by Franchised Dealers. 159

F4 Comparison of the Product-Mix Matrix for the Normal and Small-Car Patterns 160

F5 Projected 1975 Model Year Sales by Configuration Class. 162

G1 Total Vehicles-in-Use and Pre-1970 Cars Remaining as Used in All Cost Summary Calculations 201

G2 Typical Aging Factor 203

I1 Fuel Economy (mpg) by Car Class and Size 224

J1 Summary of Fuel and Emissions-Related Maintenance Data. 232

J2 Cost to Replace All Catalytic Converters in Each Car Having Them 234

K1 Comparison of Industry and Panel of Consultants on M/C Vehicle Costing for Vehicle 9 (a 1971-72 subcompact) in Scenario B 241

K2 Nominal Selling Prices (in dollars) by Car Size Developed by the Panel of Consultants on M/C. . . . 242

M1 Summary of Investment Costs by Vehicle for the Various Scenarios 252

M2 Summary of Investment Costs by Year for the Various Scenarios 291

N1 Abbreviations Used in the Cost Summary Output Reports 296

FIGURES

Figure	Title	Page
5-1	Marginal Costs of Achieving Standards on Schedule for a Single Car.	37
C1	Standard Pattern of Disaggregation Used in Creating the Product Data Base	104
D1	Production Flow in Automotive Manufacturing. .	112
E1	Typical EFI System	140
E2	Engine Displacement (CID) as a Function of Car Weight for 1973 Model Year, U.S. Produced Cars	146
E3	Comparative Performance of U.S. Produced, 1973 Gasoline Engines and Three Imported Gasoline Engines.	147
I1	CMVE Smoothed Fuel Consumption for Early 1970's Baseline Car by Inertial Weight.	223
K1	Cost Structure in Automotive Manufacturing . .	236
K2	Relationship of Markup Factor to Manufacturing Cost	240
L1	Schematic of the Procedure for Calculating Investment Costs	244

1. INTRODUCTION

The broad task of the Panel of Consultants on Manufacturability and Costs was to assess the capability of the U.S. automotive industry to produce a variety of alternative emissions technology and to compare the associated fuel, maintenance, sticker price and investment-cost penalties to the driving public. More specifically, the task was:

> Evaluate the manufacturing requirements to produce the configurations for optimum fuel economy for various levels of NO_x as determined by the Panel of Consultants on Technology.
>
> Develop various implementation schedules for preproduction and mass production as agreed upon with the Panel of Consultants on Technology and determine the cost impacts on automotive manufacturing facilities, fuel facilities, and related vendor resources.
>
> Determine the costs to car owners for the various configurations considering benefit and penalty costs as well as hardware, maintenance, fuel and design or weight penalty costs.
>
> Determine the investment capital costs of tooling, equipment and facilities and amortize these over the production schedules.

The basic data on which this consultant report is built were gathered from several sources:

1. Visits by the Panel of Consultants to manufacturing plants (Appendix A).
2. A questionnaire sent by the Panel of Consultants to the four major U.S. automotive companies (Appendix B).
3. Data and evaluation obtained from the Panel of Consultants on Technology in this study (Appendices C,I,J).

4. Data on the projected cost of gasoline and diesel fuel from a special Subpanel of Consultants on Fuels (Appendix H).
5. Assessment of manufacturing technology and capability by individuals on the Panel of Consultants on Manufacturability and Costs (Appendices D,E).
6. Results, using data from the prior five sources, from the Panel of Consultant's own calculations (Appendices F,G,K,L,M,N).

In the course of this work, a very large amount of data was collected and analyzed. Consequently, a special effort has been made in the presentation of this consultant report to provide as much of this data as space permitted in the Appendices for direct use by the Committee on Motor Vehicle Emissions[1] and future investigators. Some of the more compelling implications of the data are then discussed in brief in the main body of this consultant report.

---

[1] This same data has also been made available to Professor Donald N. Dewees of the Committee on the Costs and Benefits of Automobile Emission Control, NAS/NAE (hereinafter called the "CBC Report").

2. INDUSTRY ACTIVITY THROUGH 1974

The U.S. automobile industry has moved ahead on many fronts since the time of the report[1] of our antecedent Panel of Consultants in January 1973. Therefore, the present study had to be formulated to evaluate the activity during the periods July 1972 to July 1973 as a basis for projecting future automotive manufacturability and costs. In this section we shall describe the basic working design for the Panel of Consultants and what was learned regarding industry activity through September 1974.[2]

The basic design for the Panel of Consultant's work in this study was as follows:

Data Gathering and Manufacturing Assessments
- o Assessment of capability of the machine-tool industry to make transfer-line equipment;
- o Assessment of the capability of U.S. industry to manufacture alternative engines.

Systematic Analysis of Costs
- o Definition of relevant vehicle configurations;
- o Construction of detailed data bases for components and manufacturing resources;
- o Establishment of alternative patterns of standards of interest to the Committee;
- o Projection of total yearly car sales and product mix by car size;
- o Development of detailed time-phased production plans (scenarios);
- o Simulation of automobile industry use and shift of resources, including production balancing and plant conversion;

---

[1] Manufacturability and Costs of Proposed Low Emission Automotive Engine Systems, Report by the Panel on Manufacturing and Producibility to the Committee on Motor Vehicle Emissions, National Academy of Sciences, January 1973.

[2] This section of the consultant report was completed in September and not revised, whereas, other portions were completed in November 1974.

- Calculation of total cost to owner of all vehicles in use, including fuel, emissions-related maintenance, and sticker-price costs.

The overview results of the Panel of Consultant's work are presented in the main body of this Consultant report and the supporting detail is contained in the Appendices.

The automobile companies have made numerous changes to the engines and vehicles since 1970 in response to the requirements of the Clean Air Act amendments. These changes, mostly to the engines, have created the need for major investments in development engineering and also in equipment, manufacturing engineering and facilities. The Panel of Consultants has summarized the major manufacturing investments between 1970 and 1975 by major component in Table 2-1. The estimated expenditures by the automobile companies in the United States for the years 1970 through 1974 for emissions-related and fuel-economy-related improvements are approximately $654 million, of which the Panel of Consultants estimates that $452 million, or about 70%, is tooling and equipment, and the balance, launching and facilities costs.

The anticipated investment cost for 1975-1985 will be estimated later for alternative hypothetical scenarios.

The catalytic-converter-manufacturing facilities, typical of the emissions-related investments up to 1975, are among the most modern mass-production facilities for metal fabrication components in the United States. Once the decision was made to produce pellet-type converters, a new facility was built and new tooling and equipment were provided within 18 months. The product development had been completed between 1973 and 1974, so the whole process took about three to four years. The investment totalled $150,000,000 for launching, equipment and facilities for a facility with the capacity to produce 6,500,000

TABLE 2-1

Emissions-Related Investments by U.S. Automobile Companies

COMPONENTS	YEAR OF INVESTMENT	TOTAL INVESTMENT[1] (Thousands of dollars)
PCV Valve	1968/1970	3,300
Fuel Evaporation Control	1970/1974	2,300
Transmission Spark Control	1972	1,700
Air Pump	1973	50,000
	1974	35,000
Air Injection Controls	1973	5,000
	1974	5,000
Air Injection Piping	1973	1,100
EGR Valves	1974	3,300
PEGR Valves	1974	4,900
Exhaust Manifolds	1973/1974	12,800
Intake Manifolds	1973/1975	34,500
Coolant Radiator	1972/1973	9,000
Anti-dieseling Solenoid	1973/1975	7,300
Carburetor	1974	12,000
Aluminum Die Casting	1974	5,300
Electric Choke	1974	3,300
Altitude Compensation	1976	31,500
High Energy Ignition	1975/1976	30,000
Carburetor - Venturi	1974/1975	50,000
Aluminum Die Casting	1974/1975	9,500
Venturi Components	1974/1975	7,000
Carburetor - IFC Air Valve	1974/1975	40,000
Aluminum Die Casting	1974/1975	9,500
IFC Components	1974/1975	4,000
Pellet Catalytic Converters	1974	16,000
Pellet Can	1974	123,000
Pellets	1974	10,800
Alloy Y Piping	1974	2,800
Monolith Converter	1973/1974	73,000
Monolith Can	1973/1974	11,000
Monolith Substrate	1973/1974	22,000
Monolith Catalysts	1973/1974	8,500
Alloy Y Piping	1973/1974	2,800
Lean Thermal Reactor	1975/1976	6,800
TOTAL		654,000

---

[1] Total Investment includes engineering and launching costs, equipment and tooling costs, and facilities costs.

catalytic converters. Using a three-year period for investment recovery, the added investment cost per converter is about $8.00.

The major companies are also making major investments in new, small engines by bringing in engines of European design from their overseas divisions. The tooling and transfer lines have been ordered from U.S. tooling companies totaling $33 million. Not all of these are complete engine lines. In some cases, current lines will be converted, and in other cases new head manifold lines will be introduced to run in parallel with the current engine production lines. The current estimate is that 8 to 10 new engine lines have been ordered for model years 1976 and 1977 production of smaller vehicles to achieve better fuel performance and lower emissions. The addition of 10 new engine lines would increase the number existent from 30 to 40. In some cases, new tooling is being provided for aluminum manifolds (4.76 lbs each), saving 15 pounds per engine for a 1.3 liter, 4-cylinder engine.

The summary of planned new engine production is:[2]

> Two V-6 engines are being introduced in 1976 and 1977 for compact and intermediate cars. The Panel of Consultants has not included this engine in the scenarios but it has included it in the data base.
>
> Several 4-cylinder engines ranging from 104 CID to 150 CID are being tooled for 1977 production. These engines have reputations of being economical engines. These engines are planned for mini-compact, compact and subcompact cars.
>
> Two V-8 engines with displacements of approximately 262 CID have been evolved from heavier designs to provide lighter engines for intermediate and standard cars.

---

[2] This synopsis was collected primarily from Metal Working News, June to October 1974.

The Wankel rotary engine has been tooled for limited production of about 250,000 engines per year. The manufacturing and design engineers are debugging the design and the manufacturing processes. Automated assembly and testing have been included in the Wankel tooling. The vendors for seals are still offering test components to improve the fuel economy components to improve the fuel economy of the Wankel engine. One company has eliminated the thermal reactor to reduce the back pressure and power loss. It has replaced it with a pellet converter to gain fuel economy and emissions control.

There is no evidence that a light automotive diesel will be in production in the U.S. in the next two years.

Some evidence exists that suggests that stratified-charge engines may be in production in the next two or three years. The conversion can be made rapidly by using the slightly modified current components and adding new head designs onto existing transfer lines.

Some advanced planning has been done on electronic-fuel-injection systems, but only tentative mass-production commitments have been made at this time.

The 1975-76 expenditures for emissions and fuel-economy tooling will probably be concentrated on fuel-economy engines and weight reduction for which the companies have ordered tooling and equipment tooling of $33 million, exclusive of $93 million in launching and facilities costs.

In an economic environment which is changing rapidly, such as that in which the auto industry currently finds itself, it is natural to establish operational priorities. Informal discussions with industry representatives suggest that the emphasis currently runs in the following order: (1) fuel economy improvements, (2) emissions, (3) safety, and (4) cost reductions. Because of these interactions and priorities, it is clear that the Panel of Consultants must consider what is happening and what is possible in emissions work in the context of other concurrent activities, particularly the energy crisis.

It is the energy crisis of 1973-1974 which has forcefully raised fuel economy to first priority. The effect has been a marked drop in total sales in 1974 (estimated here as 11% overall), a shift to smaller cars, and consideration of fuel-conserving changes to the vehicle. These latter changes, including radial tires, reduced weight and drag, and fuel-conserving transmissions and axle ratios, when combined, have the potential for 25% to 40% improvement in fuel economy over 1973 cars. These changes, which are not included in the fuel-economy estimate of the present study, could be accelerated when the report of the 120-day EPA/DOT study authorized under the Emergency Energy Bill of 1974 is completed in October 1974. The industry has anticipated these changes to some extent as follows:

> The percentage of new cars fitted with radial tires as standard equipment will approach 90% in 1975 and 100% in 1976. The reduction in rolling friction generates a fuel-economy improvement varying between 3.0% and 4.0% depending upon vehicle sizes.
>
> The drive systems will be improved to reduce driving loads, thereby improving fuel economy and emissions. Most cars will be equipped with "economy" rear-axle ratios. Overdrive is expected to return as optional equipment. In the case of at least one domestic model, it will appear in the form of a fifth gear in a manual transmission. It will also surface as the fourth gear in an automatic transmission. It has been proposed that a "lock-up mechanism" be provided in automatic transmissions to reduce slip and thereby reduce fuel usage. Some experts project between 0.5 to 1.0 miles per gallon improvement in fuel-economy performance.
>
> The vehicle-design improvements that will contribute to improved fuel economy and lower emissions are unitized body designs eliminating the heavy frames, use of aluminum components for hood levers, door liners and trunk components, and use of plastic components for the grill and energy-absorbing bumper systems. These changes can reduce the total vehicle weight between 300 to 500 pounds without a new vehicle concept design. The investments to achieve these improvements could total

$55,000,000 for the body component changes and $147,000,000 for the new bumper savings. These changes could add 2.0 to 3.0 miles per gallon to fuel usage performance.

As the tasks of the Panel of Consultants were defined, such changes for achieving fuel-economy savings are outside of its scope of work. They must be taken note of here initially, however, to reflect properly the rapidly changing environment which characterizes the industry after the energy crisis.

3. VEHICLE CONFIGURATIONS CONSIDERED[1]

For every emissions standard considered in this study, one or more sets of emissions technology are expected to meet that standard. Each technology configuration or system which meets a specified standard constitutes a vehicle class. Within a vehicle class there are seven vehicle sizes. These range from a mini-compact through five intervening cars, up to a luxury car. The size definition of these seven sizes is unchanged for all classes, although the technology used in building cars of each size varies. See Table 3-1 for definitions of the seven sizes.

All sizes of vehicles in a given class will have essentially the same hardware, but will differ in list price, fuel consumption, and maintenance cost. Thus, a single vehicle configuration is uniquely determined by its hardware, its maintenance cost, fuel use, and emissions standard. Adding or deleting even one emissions-control part requires creation of a new vehicle class. Similarly, retuning an engine to meet two different standards (with different fuel economy) would require two classes, even if the hardware were identical. Thus, half a dozen vehicle classes may be defined to meet a single emissions standard, so that alternate technologies must be compared. The total number of vehicle configurations will be seven times the number of vehicle classes, to allow for the seven sizes.

It is clear that specifying vehicle configurations requires detailed knowledge of how standards will or could be met. We have, of course, such information for all standards applied through 1974 from observing what has been manufactured. In addition, the designs for

---

[1] The text for Sections 3, 4 and 5 of this report is adapted from an analysis of the Panel of Consultants data presented by Prof. Donald N. Dewees as Chapter 2 of the September 1974 CBC report.

TABLE 3-1

Definition of the Seven Vehicle Sizes in Each Vehicle Class

Type	Cylinders	Engine Displacement (CID)	Current Example
1. Mini-Compact[1]	4	90	Honda Civic
2. Subcompact	4	153	Vega
3. Compact	6	250	Dart
4. Intermediate A	6	290	Torino
5. Intermediate B	8	350	Chevelle
6. Standard	8	400	Fury
7. Luxury	8	450	Buick Electra

---

[1] There is currently no domestic mini-compact. Two examples of foreign mini-compacts are the Honda Civic and the Austin Mini.

1975 cars are committed at this time so that they can be known with some certainty. Even 1976 models can be anticipated with great accuracy at this time, since the production planning lead time for components is over one year. We can, therefore, specify the hardware to be incorporated in 1976 cars with a high degree of reliability, based upon interviews with manufacturers, suppliers, and the machine tool industry which produces the equipment that will manufacture the hardware itself.

At this time, it is unclear what standards will be applied in 1977 and later years, since the current legislation for 1977 may be modified in some respect. For 1977 and future years, we have made the best possible estimates of hardware to be employed by manufacturers based upon current technological capabilities and the stated intention of the manufacturers themselves. While we have reasonable confidence in our 1977 configurations, our confidence must necessarily diminish in later years. It is very difficult to anticipate with precision what technology may emerge in the late 1970's and early 1980's and when that technology might be employed. We have, therefore, taken the conservative approach of evaluating the systems most likely to be employed, and some which are less probable but show promise of good cost effectiveness. It is important to state explicitly, however, that while we do estimate the cost effectiveness of systems which have the potential of meeting the U.S. 1978 standards, to our knowledge none of these systems has yet met this standard for 50,000 miles.

The vehicle classes available in the present study are listed on Table 3-2. In total there are 31 classes, each with 7 vehicles of different size for a total of 217 vehicles. More vehicles are listed in Table 3-2 than were actually used in the scenarios to be described later, simply because the possibility existed to the very last moment that a wider selection of vehicles might be needed. Each vehicle is

TABLE 3-2

Vehicle Classes Available in the Current Study

		Statute Emissions				CVS-CH Equivalent Emissions***		
Class No.*	Vehicle Description**	HC	CO	NO_x	STD	HC	CO	NO_x
22	OC STD/CARB	2.2	23.0	NR	F70	3.9	33.3	6.0
1	OC STD/CARB	3.4	39.0	NR	F72	3.0	28.0	5.0
8	OC STD/CARB AI/EGR	3.4	39.0	3.0	F73-4	3.0	28.0	3.1
15	OC STD/CARB EGR	"	"	"	"	"	"	"
29	OC VEN/CARB AI/DEGR	1.5	15.0	3.1	F75	1.5	15.0	3.1
36	OC VEN/CARB DEGR/HCAT	"	"	"	"	"	"	"
43	OC VEN/CARB AI/DEGR/HCAT	0.9	9.0	2.0	C75	0.9	9.0	2.0
106	OC EFI/ECU PEGR/02	"	"	"	"	"	"	"
50	OC VEN/CARB AI/PEGR/HCAT/EFE	0.41	3.4	2.0	I77	0.41	3.4	2.0
57	OC VEN/CARB PEGR/TR/EGR	"	"	"	"	"	"	"
85	OC/SC VVEN/CARB TR	"	"	"	"	"	"	"
99	OC EFI/ECU PEGR/HCAT	"	"	"	"	"	"	"
113	OC/SC EFI/ECU PEGR	"	"	"	"	"	"	"
169	W STD/CARB TR/AI	"	"	"	"	"	"	"
176	W AV/CARB IFC/HCAT	"	"	"	"	"	"	"
190	D/DC MFI	"	"	"	"	"	"	"
204	OC/MFI ECU/EGR/HCAT	"	"	"	"	"	"	"
211	OC/SC MFI/HCAT	"	"	"	"	"	"	"
134	OC EFI/ECU HNCCAT/02	0.41	3.4	1.0	None	0.41	3.4	1.0
155	OC/SC/MFI EGR/HCAT	"	"	"	"	"	"	"
197	D/DC MFI/EGR	"	"	"	"	"	"	"
218	OC VEN/CARB AI/EFE/HNCAT	"	"	"	"	"	"	"
225	OC/SC VEN/CARB PEGR/TR	"	"	"	"	"	"	"
232	W AV/CARB IFC/02/HNGCAT	"	"	"	"	"	"	"
64	OC VEN/CARB AI/PEGR/HNCAT/EFE	0.41	3.4	0.4	F78	0.41	3.4	0.4
71	OC VEN/CARB AI/EFE/HNGCAT	"	"	"	"	"	"	"
78	OC VEN/CARB AI/PEGR/TR/QTR/NCAT	"	"	"	"	"	"	"
92	OC/SC VVEN/CARB PEGR/TR	"	"	"	"	"	"	"
127	OC AV/CARB ECU/02/AI/PEGR/ HNCCAT	"	"	"	"	"	"	"
141	OC EFI/ECU AI/PEGR/HNCCAT/C2	"	"	"	"	"	"	"
148	OC/MFI EGR/HNCCAT/ECU/02	"	"	"	"	"	"	"

---

* The class number is the same as the vehicle number of the mini-compact in that class.

** Definitions for the Vehicle Description Code:

Engine Type
OC = Otto cycle (conventional)
SC = Stratified charge
W = Wankel
D = Diesel

Fuel Induction
STD = Standard carburetor
VEN = Venturi carburetor
VVEN = Variable Venturi carburetor
AV = Air Valve carburetor
IFC = Integrated fuel control
EFI = Electronic fuel injection
MFI = Mechanical fuel injection
FI = Diesel fuel injection
ECU = Electronic emission control unit
EFE = Early fuel evaporation
DC = Divided chamber diesel

Emission Control
AI = Air injection
EGR or E = Exhaust gas recirculation
DEG or D = Dual diaphragm exhaust gas recirculation
PEG or P = Proportional exhaust gas recirculation
HCAT = Oxidizing catalyst
HNCCAT = 3-way catalyst
HNGCAT = Dual catalyst plus getter
TR = Exhaust thermal reactor
02 = Oxygen sensor for feedback
QTR = Questor

*** Emissions conversion from Prof. Donald N. Dewees, NAS Committee on Costs and Benefits of Automotive Emission Control Report, p. 123.

built up of approximately 90 subunits (body, engine, chassis, etc.) for purposes of determining the unit costs and the requisite manufacturing units needed to make the vehicle. A typical breakdown of an Intermediate A vehicle of Class 50 is given in Appendix C.

Each vehicle configuration has associated with it a fuel consumption (Appendix I), an expected maintenance cost for emissions hardware (Appendix J) and a list price exclusive of investment (Appendix K). The investment cost for a particular vehicle configuration will vary depending on the scenario under which it is built.

Investment costs, those costs related to providing the production facilities required to make a specified time-phased pattern of vehicles, were allocated in two different alternative ways. In the first analysis, the investment costs and investment recovered are allocated to the vehicles which subsequently use the part made in a particular facility. For example, all cars requiring a diesel fuel pump made after the new fuel pump facility was built would share equally the cost of building the facility. The total investment cost for a diesel vehicle would then simply be the sum of these investment costs from the production resources which it used.[2]

The second method of presenting investment cost was simply to sum the total investments made in a given year and sum the total investment recovered. The values and the net value obtained by adding them (investment recovery being considered as a negative investment) could then be displayed on a yearly basis. Both types of investment data for the scenarios are given in Appendix M.

---

[2] For the purposes of calculating investment costs, the basis for comparison is Scenario A. In Scenario A, the 1970 car (Class 22) continues to be built from 1970 through 1985. The costs of all other scenarios are then the increment required over Scenario A costs.

Two methods are also used to determine the operating costs of alternative policies. The first method, the "single-car study", uses data specifying the average cost per car for an Intermediate A-size vehicle, in configurations designed to meet each of a number of standards. The costs for these configurations are used to address the basic questions of interest. All costs are compared to those for a car meeting the 1970 pollution-control standards.

The second method of cost comparison is to define a set of scenarios, and to calculate the pollution-control costs involved for all cars in each scenario.[3] A scenario specified the number of cars of each type sold in each year over the period to be considered, the pollution-control standards which new cars must meet in each year of the period and the control technology to be used. The difference between scenarios is the emissions standards and their date of adoption. Over a dozen scenarios have been defined to explore the issues of interest to the Committee on Motor Vehicle Emissions.

---

[3] As noted, the single-car comparisons and the cost summaries calculated for a given scenario have basically different purposes and caution must be used in moving from one to the other. Single-car comparisons focus on the Intermediate-A car, which is smaller than a typical car in 1973, slightly smaller than the typical car in 1985 for the normal size-mix pattern, and larger than a typical car in 1985 for the small-car size-mix pattern. Thus, any hypothetical calculation using data for an Intermediate-A car as typical could be substantially in error.

4. SCENARIOS CONSIDERED[1]

4.1 Sales Volume and Mix

The seven vehicle sizes listed in Table 3-1 above are defined by engine and body sizes that are constant throughout all years of all scenarios. Also identical in all scenarios are total sales each year and (except for the small-car scenarios) the allocation of total sales among vehicle sizes. Table 4-1 shows new car sales for each year from 1970 through 1985 as used in the scenarios, including domestic production for domestic use, imported cars, and the total of all cars sold in the United States. The figures for 1970 through 1973 are taken from historical sources (see Appendix F). It is assumed, based on sales in early 1974, that the total car-sales volume drops in that year by 11%. We then assume that sales increase at an annual rate of 3.5% per year from 1974 until 1985. This growth rate is slightly less than the historical growth rate. Thus, we assume that the increased fuel price which contributed to the drop in sales in 1974 has a continuing effect uniform over the remainder of years. In short, there is no sudden recovery from the 1974 slump. Foreign cars are assumed to hold 15% of the market after 1974.

Many people attempt to forecast auto sales, and the validity of the figures presented here is subject to endless debate. Since all scenarios use the same numbers, errors in the estimated total sales will affect the total cost of all scenarios approximately equally. The difference in cost from one scenario to another will be little

---

[1] The scenarios were developed jointly by the Committee on Costs and Benefits of Automotive Emission Control (CBC) and the Committee on Motor Vehicle Emissions (CMVE). Most of the data were gathered by the Consultant Panel on Manufacturability and Costs of Proposed Low-Emissions Automotive Engine Systems of the CMVE.

TABLE 4-1

Projected New Car
Sales in the United States 1970-1985
(millions of vehicles)

Year	Domestic Production[1]	Foreign Production[2]	Total U.S. Purchases
1970[3]	7.12	1.23	8.35
1971[3]	8.68	1.53	10.2
1972[3]	9.32	1.59	10.9
1973[3]	9.67	1.73	11.4
1974[4]	8.63	1.52	10.2
1975	8.93	1.58	10.5
1976	9.24	1.63	10.9
1977	9.56	1.69	11.3
1978	9.90	1.75	11.6
1979	10.2	1.81	12.1
1980	10.6	1.87	12.5
1981	11.0	1.94	12.9
1982	11.4	2.00	13.4
1983	11.8	2.07	13.8
1984	12.2	2.15	14.3
1985	12.6	2.22	14.8

---

[1] U.S. dealer sales of U.S. and Canadian-produced vehicles.

[2] Net imports to U.S. except from Canada.

[3] From Ward's Automotive Yearbook.

[4] An 11% drop in total U.S. sales (purchases) is assumed in 1974, and growth at 3.5% per year thereafter.

affected by total sales volume and the ranking of scenarios in terms of total costs insensitive to sales volume.[2]

The allocation of domestic vehicles sales each year to the seven vehicle sizes is shown in Table 4-2. Here the relative sales volume changes substantially between 1970 and 1980, and is assumed to remain constant after 1980, since there is no clear reason to predict further changes. This allocation of sales is based upon extensive discussions with personnel in the automobile industry in Detroit and upon our own interpretation of outside forces operating on the automobile market.

Production[3] of the subcompacts grows from 0% in 1970 to 14% in 1980. Sales[3] of the full-sized V-8 drop from over 20% of the market in 1970 to 12% in 1980. Even the luxury car loses 3% of the total industry sales volume or 20% of its own sales volume throughout this period.

These substantial shifts from large to small cars are extrapolations of current trends, and reflect the continuing effect of higher fuel prices throughout the period of the scenarios. Recall that we assume gasoline prices to have risen from 42¢, including tax, in 1973 to 55¢, including tax,in 1974, and to remain there until 1985. This 40% price

---

[2] It is unlikely that errors in the total vehicles in use, and, thus, total costs, could exceed 10%, which is small compared to possible sources of error in both cost and benefit calculations.

[3] In the scenarios, it is assumed that production and sales essentially remain in balance (no inventory fluctuation) and, hence, production and sales are equivalent.

TABLE 4-2

Percentage of Annual Domestic Production for Domestic Sales by Vehicle Type: Normal Scenarios

	Size Category (CID)						
Year	1 (90)	2 (153)	3 (250)	4 (290)	5 (350)	6 (400)	7 (450)
1970	0	0	13	19	32	21	15
1971	0	7	12	18	30	19	14
1972	0	9	11	18	29	19	14
1973	0	8	10	18	30	21	13
1974	0	9	11	18	29	20	13
1975	1	10	12	18	28	18	13
1976	2	11	13	18	27	16	13
1977	3	12	14	18	25	15	13
1978	3	13	15	18	25	14	12
1979	3	14	16	18	24	13	12
1980-85	3	14	17	18	24	12	12

Note: Foreign cars not shown here.

CID = Cubic-Inch Displacement

increase is expected to continue to shift the market away from large automobiles towards smaller, more economical models--a shift reflected in Table 4-2.

As is the case with total sales, the allocation of sales by vehicle size (Table 4-2) is identical for all except the small-car scenarios. Thus, if the future actual market shares of various sizes of vehicles are somewhat different than that specified here, they will affect all scenarios equally, and have little impact on the relative costs of the alternative policies.

In the investment analysis, the impact of a scenario on the U.S. industry only is considered. Hence, for the investment analysis, Tables 4-1 and 4-2 only are needed to define the yearly production volume by car size. In the Cost Summary analysis, however, in use are of concern. These include vehicles remaining from pre-1970 sales, as well as yearly additions of domestic and imported cars. In this case, a pattern of import car sales by car size was developed as shown in Table 4-3. In this table, the current tendency of foreign manufacturers to gradually move toward somewhat larger cars is apparent.

The market shares for the small-car scenarios are shown in Table 4-4. By 1980, the shares of the three smallest sizes are shown as 8%, 21%, and 23%, compared to 3%, 14%, and 17% in the normal scenarios. The largest three sizes occupy 12%, 4%, and 8% of the market, compared to 24%, 13% and 12%. While these shifts are not revolutionary, they represent a substantial short-term shift in size mix. The small-car pattern effectively levels the total industry auto sales dollar volume for the next decade because of the smaller list price of smaller cars (see discussion in Section 8). A more radical shift to small cars would lead to an actual decline in automobile sales revenue.

TABLE 4-3

Percentage of Imported Cars by Size

Year	Size Category (CID) 1 (90)	 2 (153)	 3 (250)	 4 (290)	 5 (350)	 6 (400)	 7 (450)
1970	4	90	4	1	1	0	0
1971	4	90	4	1	1	0	0
1972	4	90	4	1	1	0	0
1973	4	90	4	1	1	0	0
1974	5	86	6	2	1	0	0
1975	6	83	8	2	1	0	0
1976	7	79	10	2	2	0	0
1977	8	76	12	2	2	0	0
1978	9	73	13	3	2	0	0
1979	10	71	14	3	2	0	0
1980	11	68	15	3	3	0	0
1981	12	67	15	3	3	0	0
1982	12	66	15	4	3	0	0
1983	12	66	15	4	3	0	0
1984	12	65	15	5	3	0	0
1985	12	65	15	5	3	0	0

TABLE 4-4

Percentage of Annual Domestic Production for Domestic Sales by Vehicle Size: Small-Car Pattern

	Size Category (CID)						
Year	1 (90)	2 (153)	3 (250)	4 (290)	5 (350)	6 (400)	7 (450)
1970	-	0	13	19	32	21	15
1971	-	7	12	18	30	19	14
1972	-	9	11	18	29	19	14
1973	-	8	10	18	30	21	13
1974	-	9	11	18	29	20	13
1975	1	11	13	19	26	17	13
1976	3	13	15	20	23	14	12
1977	5	15	17	21	20	11	11
1978	6	17	19	22	18	8	10
1979	7	19	21	23	15	6	9
1980	8	21	23	24	12	4	8
1981-85	8	22	24	24	11	3	8

Note: Foreign cars not shown here.

CID = Cubic Inch Displacement

4.2 Technology

Most scenarios have applied emissions-control technology that was used in the past and the best judgment as to technologies to be used in the future. At the time this is written, we know what controls have been installed through 1974. We also know what will be used in 1975, since all prototype testing for 1975 is now complete, and manufacturers are preparing to put those cars into production. We have good information on 1976 technology since contracts with suppliers and the machine-tool industry are already set for the 1976 production year. There may be small changes between now and that time, but major technological change is most unlikely.

By 1977, however, there is greater uncertainty about the devices which will be installed to meet the standards which might apply at that time, and our knowledge becomes much less certain about years after 1977. We do assume that no new technology is introduced after 1980, so that beyond that point no technological change takes place. The only changes in scenarios occur as one class of vehicle replaces another due to increases in production capacity for the new technology. For example, stratified-charge engines may be introduced in 1975, but may take several years to become a major factor in the market since the industry would need several years to increase production capacity for such a new engine.

The major problem in specifying technology occurs in the few scenarios in which no new standards are set after an early date, such as 1973 or 1975. Over time, manufacturers develop new, better, and less-expensive ways to meet any given standard. While it may have cost $35.00 to meet 1970 emissions standards in 1970, with our present knowledge, those standards could probably be met in 1974 for only a few dollars per car, particularly when the concomittant cost reductions are properly accounted. If we identify a given technology class with a given set of standards, then once a final standard is set, no technological change takes place and costs do not fall. Thus, our methods of calculation only partially account for the very real ability of the industry to lower control costs as time passes.

Cost reductions can occur in three ways. First, production experience with a given device can lead to improved production methods and greater productivity. This "learning-curve" experience is not incorporated in our data; we assume production costs after most of this learning has taken place. Thus, we show no cost changes resulting from the learning curve.

A second source of cost reduction is design improvements which yield the same performance, but reduce manufacturing cost by using less material or simpler components. In the few cases where such redesign can be anticipated, we included the new design as a separate vehicle technology class with its own cost. The historical data clearly include such product improvements, and they are incorporated in our costs. Generally, however, we cannot predict the rate of cost reduction for future devices, so costs are presented for known designs. Thus, the costs for future years are probably overstated.

A third source of cost reduction is the development of a new technology which achieves the same standards at lower cost than an earlier technology, or meets more stringent standards. The vehicle technology classes developed by CMVE include a number of devices or engines which are not now in volume production, but could be in the future. In many cases, they show dramatic cost reductions. Their emergence may depend, however, upon incentives which will induce the automobile manufacturers to bring them into production.

Stringent standards may lead directly to the development of a technology to meet them. For example, it is most unlikely that the catalytic reactors that will be installed on many 1975 cars would have been developed in the absence of the standards set for 1975 and 1976 in the 1970 amendments to the Clean Air Act. Thus, the rate of technological development may be highly dependent upon the legislated standards.

The exact relationship between standards and technological progress, however, is unclear. It has been said that the pressure of strict standards has been so great that the industry has investigated familiar technologies that were certain of meeting the standards at high cost, rather than investigating more novel low-cost technologies which could not be depended upon to meet the standards on the legal timetable. Stringent standards will lead to technological development, but it is _not_ clear that the fastest imposition of stringent feasible standards will lead to the development of the most cost-effective technology.

We have incorporated estimates of future technological change by identifying technologies likely to be used for the rest of this decade and the dates upon which they could be in volume production. It is reasonable to expect that if no further standards had been imposed after 1970 or 1973, some technological progress would have taken place. Since these developments are more hypothetical than future developments according to the current law, there is little data on costs of meeting past standards if they had not been changed. Thus, we overstate the costs of those scenarios which impose no new standards after 1970 or 1973, as compared to other scenarios which adopt more stringent standards for which we have better data on technological progress.

4.3 Emissions Rates in Scenarios

The primary difference between the various scenarios is in the emissions standards that must be met in each year. These standards and the year of their application are selected from a set we have compiled for this purpose (Table 4-5).

Each standard is expressed according to the form of measurement used when the standard was imposed, and according to CVS-CH[4] terms when the former is different. The conversion to CVS-CH is necessary because total emissions rates from a mixed vehicle fleet can be calculated only if all emissions are on a comparable basis.

All standards through US78 are ones which have been enacted into federal law as new-car standards. The C75 standard is to be applied in California in 1975. The I77 standard is the interim standard for 1977, adopted when the original 1976 standard was postponed to 1977.

Table 4-6 shows the schedule of standard application for the scenarios. Scenario A is the baseline scenario against which the others will be compared. In A, all standards are applied through 1970 as they were actually applied in the past. No further emissions controls are required after 1970. Thus, in Scenario A, vehicles built from 1970 through 1985 will all be designed to meet only the 1970 emissions standards.

---

[4] Constant volume sampling using both cold and hot starts (CVS-CH) is the official test method for federal certification beginning with 1975 vehicles. Previous tests used the cold start only (CVS-C) or the so-called federal test procedure (FTP).

TABLE 4-5

EMISSIONS STANDARDS FOR SCENARIOS

(By Legislated Test Method and by CVS-CH)

Standard Name	Year(s) Applied	Exhaust (grams/mile)			Test
		HC	CO	NO_x	
Pre-1968	1960-67	8.7	87	4.0	CVS-CH
US68	1968	3.4	35	NR	FTP
		5.9	50.8	5.0	CVS-CH
US70	1970	2.2	23	NR	FTP
		3.9	33.3	6.0	CVS-CH
US71	1971	2.2	23	NR	FTP
		3.9	33.3	6.0	CVS-CH
US72	1972	3.4	39.0	NR	CVS-C
		3.0	28.0	5.0	CVS-CH
US73	1973	3.4	39.0	3.0	CVS-C
		3.0	28.0	3.1	CVS-CH
I75	1975	1.5	15.0	3.1	CVS-CH
C75	1975	0.9	9.0	2.0	CVS-CH
I77*	1977	0.41	3.4	2.0	CVS-CH
T177		0.9	9.0	1.0	CVS-CH
T277		0.41	3.4	1.0	CVS-CH
T377		0.9	9.0	0.4	CVS-CH
US78*	1978	0.41	3.4	0.4	CVS-CH

Source: Dewees, D.N.; A Report by the Coordinating Committee on Air Quality Studies, Vol. 4, National Academy of Sciences, Washington, D.C., September 1974, Ch. 2, p. 57.

NR = not regulated

CVS-CH = Constant Volume Sampling, Cold and Hot Start

FTP = Federal Test Procedure

* These standards are referred to as I76 and US77, respectively, in the source document. Present usage corresponds to that in the Emergency Energy Act of 1974.

TABLE 4-6

Timing of Standards in Scenarios

Year	SCENARIO							
	A	B	C	E	F	I	J	K
1970	US70	US70	US70	US70	US70	US70	US70	US70
1971		US71	US71	US71	US71	US71	US71	US71
1972		US72	US72	US72	US72	US72	US72	US72
1973		US73	US73	US73	US73	US73	US73	US73
1974								
1975			I75	I75	I75	I75	I75	I75
1976						I77		
1977				I77	I77	US78	I77	I77
1978					T277		US78	
1979								
1980								US78

Source: Dewees, D. N.; A Report by the Coordinating Committee on Air Quality Studies, Vol. 4, National Academy of Sciences, Washington, D.C., September 1974, Ch. 2, p. 59.

Notes:
1. Scenario A is the Baseline Scenario.
2. The alternate technology cases are on Scenario E.
3. The small-car case is run on Scenarios C, J, and K.
4. The 2-car case applies Scenario B (or C) to 63% of the fleet, and Scenario J to 37%.
5. This listing agrees with Table 2-8 in the Source report, except that Scenario G there is called F here, and Scenarios F and H there are omitted here.

Scenarios B and C are designed to investigate how much we have paid for extending controls beyond the 1970 standards to the 1973 and interim 1975 standards. Scenario B imposes no further requirements after 1973, so that all cars built after 1973 for the scenario must meet that standard alone. Scenario C applies the interim 1975 standards (federal and California) to all vehicles produced in and after 1975. Scenarios E, F and J are designed to investigate the cost of increasingly stringent final emissions standards. Scenario J represents the recently amended legislation with 0.4 g/mi NO_x required in 1978.

Scenarios I,J and K are designed to investigate the cost difference associated with different timing of the same standards. Scenario I represents one year's postponement of the originally legislated 1975 and 1976 standards. Scenario J represents the same standards with the last two standards delayed by one year (identical to standards in the Energy Emergency Act), and Scenario K represents the same situation but with the final U.S. 1978 standards postponed until 1980. A comparison of Scenarios I,J, and K should reveal whether a more gradual approach to the same ultimate standard can save significant expenditures on pollution control, and should reveal what air-quality penalties must be suffered to achieve these savings.

Several variations were run on some of the individual scenarios. First, we explored the cost of using technological mixes that differ from those the industry plans to use. Scenario E was rerun with the introduction of diesel engines, with the introduction of the stratified-charge engine, and with the introduction of Wankel engines.[5] The introduction date was the earliest feasible (see Section 7), the introduction rate was 3-5 years, and final volumes were enough to load at least one engine transfer line. The purpose of modifying the scenario was to see whether the alternative technologies would be more or less expensive in terms of list price, fuel economy and maintenance costs than the scenario with the original technological mix.

---

[5] In the final stages of this study, a second set of E scenarios were run which eliminated the small amount of EFI (Class 134) production included in Scenarios E, ED (diesel), and ESC (stratified-charge). These were designated Scenarios E-2, ED-2, and ESC-2.

The emissions from these variations were identical, since the standards are unchanged; only the costs changed.

Another set of variations involved a rapid conversion to a mix of vehicle types in which small cars predominate. We assume that higher gasoline prices or public policies such as a tax on horsepower or taxes on the length or weight of a car would cause a more rapid shift to small cars. We simulate conversion of production capacity from large cars to small cars as rapidly as is feasible at a reasonable cost, and then compare the cost with the original scenarios. This small-car strategy was run for Scenarios C,J, and K. Naturally, small cars are cheaper than large cars, so that substantial savings appear. At the same time, the consumer may be less satisfied because he has a smaller, less powerful car than before; so care must be used in interpreting the results of these modifications. By comparing the cost increases for small cars for Scenarios C,J, and K with the cost increase for the standard car sizes for these same scenarios, we get the saving on emissions controls from producing small cars.

Finally, we considered a two-car strategy in which only part of the vehicle fleet must follow a stringent set of standards. We have defined the two-car strategy such that 63% of the fleet follows Scenario B (or C) while 37% follows Scenario J. These scenarios are identified as B'J' and C'J' in the Appendices. These percentages were arrived at by identifying all states which include metropolitan areas that the Environmental Protection Agency expects will not be able to meet air-quality standards by 1977, and by assuming that all cars in those states must meet the stringent standard. Those states included approximately 37% of the total automobile population in 1970.[6] This two-car strategy might be less expensive than if J were set for the entire country, but it would lead to higher emissions rates.

---

[6] The areas which will not meet the air-quality standards by 1977 are listed in "The Clean Air Act and Transportation Control: An EPA White Paper" by Holmes, Horowitz, Reid and Stolpman, the Environmental Protection Agency, August 1973, p. 31. The states in which these areas are found are: Pennsylvania, District of Columbia, Utah, Texas, New York, California, Colorado, Arizona, Alaska, Massachusetts and Maryland. Automobile registrations are found in the Motor Vehicle Manufacturers Association's "1972 Automobile Facts and Figures", Detroit (1973), pp. 24-25. In 1970, these states registered 32.7 million automobiles out of a national total of 89.2 million. They thus include 37% of the auto population. Incidentally, these states also contain about 37% of the human population of the country as a whole.

Covering an entire state includes many areas where strict controls are not necessary. On the other hand, if one adopted a regional rather than state-wide strategy, one would include parts of New Jersey and Connecticut which are not listed in the EPA report. There would thus be little reduction in the total number of cars controlled. Furthermore, it is administratively much easier to divide the regulation by state.

5. SINGLE-CAR COMPARISONS AND YEARLY COSTS FOR VARIOUS SCENARIOS

5.1 The Cost of Alternative Final Emissions Standards

The cost of meeting alternative emissions standards is calculated first on a single-car basis and then for the entire fleet over the fifteen years of a scenario. The single-car costs consist of the change in list price, and the maintenance and fuel-economy data associated with each selected configuration. For the single-car study, only the Intermediate-A-size vehicle is examined, and all costs are compared to the 1970 configuration. This results in an approximation of the average cost for all vehicle sizes, but an investigation of the variation of costs with size cannot be carried out.

Table 5-1 shows the 100,000-mile lifetime costs of meeting the set of legislated standards of Scenario J (plus the 1975 California standard) for the Intermediate-A vehicle. They are based on the best data available now, but rapid changes in auto pollution-control costs in the past suggest caution in relying on these results for more than the near future.

The list price for a vehicle increases steadily from the configuration meeting the 1970 standards to the configuration meeting the ultimate 0.4 g/mi NO_x standard. The largest increase occurs in 1978, when complex control systems, including an air pump, proportional exhaust gas recirculation, and a dual catalyst, will be required to meet the 0.4 g/mi NO_x emission level. Lifetime maintenance costs, calculated on the basis of the manufacturer's recommended maintenance schedule, increase through 1973, then drop in 1975 as use of unleaded gasoline reduces spark-plug and exhaust maintenance, while electronic ignition systems cut ignition adjustment and repair. The cost of fuel use increases through 1973, then decreases in 1975 as catalyst systems improve fuel economy (thus, more than offsetting the increased price

TABLE 5-1

Single-Car Costs of Standards on Schedule
(Lifetime Cost Increase Over 1970 Intermediate-A Vehicle, 1974 Dollars)

Standard	Year	Config-uration Number[1]	List Price	Life Mainte-nance	Life Fuel		Life Total		Present Value[2]
					Tax	Ex Tax	Tax	Ex Tax	Tax
US70	1970	25	0	0	0	0	0	0	0
US72	1972	4	0	275	0	0	275	275	158
US73	1973	11	49	325	379	296	753	670	432
I75	1975	39	109	100[3]	56	76	265[3]	285[3]	203
C75	1975	46	150	113[3]	184	178	447	440	330
I77[5]	1977	53	176	113[3]	184	178	473[3]	466[3]	361
US78[5]	1978	74	302	75[4]	467	407	844[4]	778[4]	649

---

[1] See Appendix A for description of each configuration.

[2] Lifetime maintenance and fuel costs discounted at 15%.

[3] Catalyst replacement at 50,000 miles would add $114.

[4] Catalyst replacement at 50,000 miles would add $312.

[5] These standards are referred to as I76 and US77 in the CBC Report.

of unleaded fuel). This decrease is sufficient to bring lifetime total costs for the interim 1975 standards well below those of the 1973 standards. Fuel costs jump again for the 0.4 g/mi NO_x standards in 1978.

It is interesting to note the relative importance of manufacturing, maintenance, and gasoline costs in the costs of these alternative standards. The range of lifetime maintenance cost is similar to the range of list price. The variation in fuel costs covers a slightly wider range than does the list price, and for several standards, the fuel-economy penalty is greater than the list-price cost. No one cost component alone can adequately reflect total costs.

Several other studies have estimated the costs of auto-emissions control. Prominent among these is that of the Environmental Protection Agency (EPA), shown in Table 5-2, with the fuel prices and other costs adjusted to 1974 dollars to be consistent with our other calculations. The primary difference between our costs and those of the EPA is that the EPA shows almost negligible maintenance costs for all standards, while we show significant maintenance costs, especially in 1972, 1973, and 1977. Part of this difference arises because the EPA considers only the cost of maintenance permitted during a certification procedure test, while our maintenance costs include those recommended by the manufacturers. Our costs include all items which can affect emissions, including tune-ups, air-filter replacement, and even oil-filter replacement. The EPA maintenance costs may understate the cost of maintenance which would be required to keep a car within reasonable bounds of its emissions standard over the full 100,000-mile life. Still, their figures show lifetime-total costs and the present value of those costs rising steadily through the 1977 standards.

TABLE 5-2

Costs of Standards on Schedule, Other Studies
(Lifetime Costs, Gasoline Tax Included)
(Cost Increases Over 1970 Vehicle, Fleet Average Per Car)

Study	Standard	Year	Configuration	List Price	Lifetime Costs		
					Maintenance	Gas	Total
EPA[1]	US70	1970	NI	0	0	0	0
EPA	US73	1973	NI	55	0	209	264
EPA	I75	1975	NI	242	20	44	306
EPA	I77	1976	NI	268	40	201	509
EPA	US78	1977	NI	337	120	241	598
NAS[2]	US70	1970	NI	0	0	0	0
NAS	US73	1973	EGR, AI	74	NE	NE	74+
NAS	I77	1975	CAT	232.80	NE	NE	233+
NAS	US78	1976	DUAL CAT	366.80	NE	1042[3]	1408+

---

[1] "The Cost of Clean Air--1974," The Environmental Protection Agency, May 1974, Draft Version, CH III, pp. III-7, 8, 9, 11, 13, 14. Converted to 1974 dollars, 55¢/gallon of gasoline.

[2] Report by the Committee on Motor Vehicle Emissions, National Academy of Sciences, February 1973, pp. 94, 102-3. Converted to 1972 dollars.

[3] The NAS assumes a 25% fuel penalty in 1976 over 1970, which at 55¢/gallon would cost $1,042 over 100,000 miles.

NE = Not Estimated
NI = Not Indicated

The cost estimates from a 1973 National Academy of Sciences report are also shown in Table 5-2. The list price changes are quite similar between the EPA and NAS reports, but the NAS assumption of a 25% fuel-consumption penalty for the dual-catalyst car yields a much higher fuel-cost estimate for the final 0.4 g/mi NO_x standard. The list price increases shown in Table 5-1 are about $50 less than the previous NAS estimates, despite decreases in the value of the dollar.

Another way of examining emissions cost data is to relate them to the emissions standards themselves, by dividing the emissions reduction of each standard into the incremental lifetime cost for that standard. In the absence of a generally accepted emissions index, consider the average percent reduction in exhaust emissions of each of the three pollutants from a controlled car as compared to an uncontrolled car. Figure 5-1 shows the increase in total lifetime costs for each standard from Table 5-1 divided by average percentage reduction in emissions for that standard, when plotted against the average percentage reduction in emissions. These marginal costs rise to 1973, then become negative with the introduction of catalysts and unleaded gas in 1975. From 1975 to 1977 they rise even more abruptly than before. Thus, total costs and marginal costs increase as the degree of control increases, except when new technology in the form of catalysts is introduced in 1975. In short, technical progress can overcome the tendency of marginal costs to rise continuously with the degree of control.

The above calculations are for changing emissions standards over time. It is also interesting to analyze the costs incurred by different standards imposed at a particular time. Since new technologies become available and can be produced in high volume as time

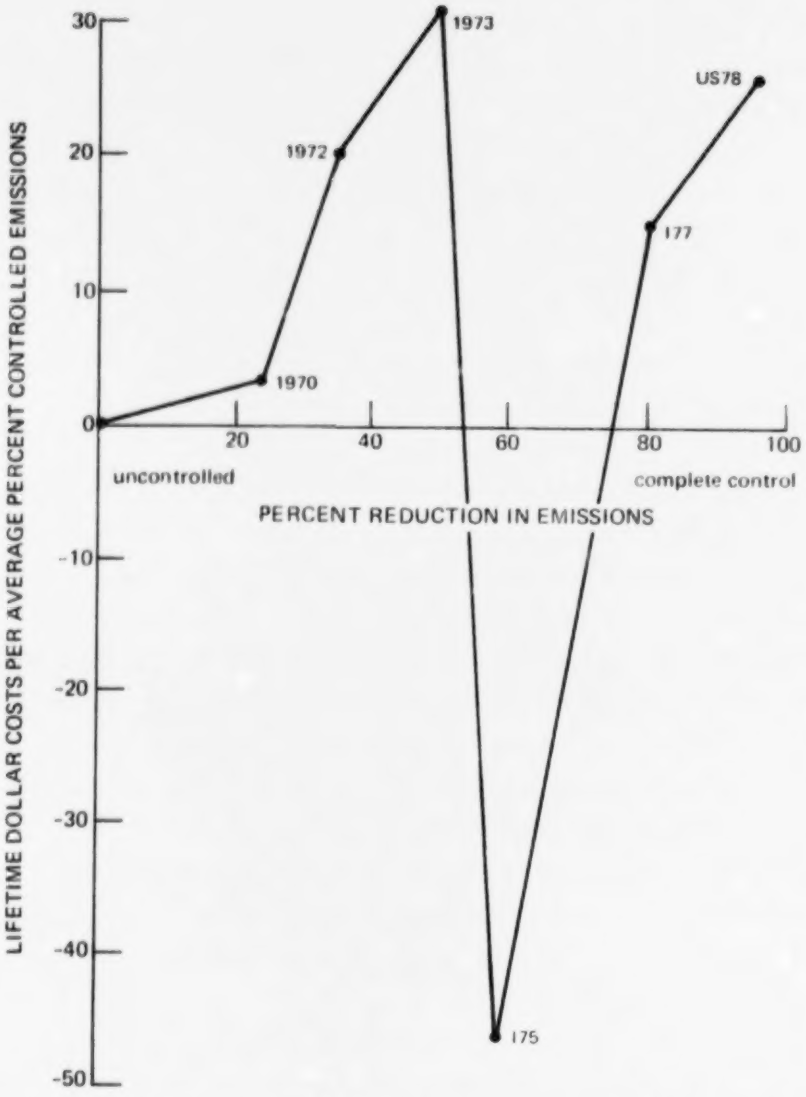


FIGURE 5-1 Marginal Costs of Achieving Standards on Schedule for a Single Car.

progresses, the cost of achieving a given standard declines over time. For example, the 1970 standards could now be met at almost no total cost penalty over an uncontrolled car. We have, therefore, calculated the cost of meeting the 1976-1978 standards in 1980-1985, using technology which might possibly be in volume production at that time, depending upon the imposition of standards and industry commitments. The results of these calculations, using current cost estimates for that technology, are shown in Table 5-3. These are, of course, highly tentative, since all technologies could change substantially in the intervening years. The standard of comparison is still the technology used for meeting the 1970 standards.

The data of Table 5-3 suggest that by the early 1980's the cost of meeting the I77 standard will be little greater than for meeting the I75 or C75 standards, so they are all compared together. The I77 standard can be met by a diesel, which could be in large-volume production by the early 1980's. This vehicle, Configuration 193, saves $899 in lifetime costs, including fuel tax, compared to the 1970 car. Problems of noise, odor, and performance may, however, limit diesel-market presentations.[1] An advanced stratified-charge engine, which would save $252 over its life compared to a 1970 car, could be available about the same time. Thus, this high degree of control is costless for some engine types by the early 1980's, if these data accurately reflect the costs and performance of these systems.

The Scenario F standards, with a 1.0 g/mi NO_x level, can also be met by a diesel vehicle, but with exhaust gas recirculation. The

---

[1] The diesel scenario shows less than 10% of new cars equipped with diesels in 1980. This suggests the difficulty or cost of producing these engines in very large volume in a short time.

TABLE 5-3

Single-Car Costs of Various Standards in 1980-85
(Lifetime Cost Increase Over 1970 Intermediate-A Vehicle, 1974 Dollars)

Standard Name	NO_x Standard	Configuration Number[1]	List Price	Life Maintenance	Life Fuel		Life Total		Present Value[2]
					Tax	Ex Tax	Tax	Ex Tax	Tax
US70	-	(25) 1970 Baseline Car	0	0	0	0	0	0	0
I77 (also I75 and C75)	2.0	(193) Diesel	131	-75	-955	-733	-899	-717	-533
		(214) CCS	201	13[4]	-465	-335	-252[4]	-122[4]	- 94
T277	1.0	(137) EFI with 3-way Cat.	284	13[3]	56	76	352[3]	372[3]	327
		(200) Diesel	149	-25	-633	-524	-509	-400	-277
US78	0.4	(144) EFI with 3-way Cat.	359	38[4]	152	152	548[4]	548[4]	479
		(151) MFI with 3-way Cat.	347	38[5]	286	258	671[5]	643[5]	555

---

[1] All vehicles are Intermediate A cars. See Table 3-2 for description of each configuration.

[2] Assuming 15% discount rate.

[3] Replacement of the complete catalytic unit at 50,000 miles would add $156.

[4] Replacement of the complete catalytic unit at 50,000 miles would add $114.

[5] Replacement of the complete catalytic unit at 50,000 miles would add $135.

Strat=stratified charge engine; EFI= electronic fuel injection; MFI=mechanical fuel injection cost is actually a saving of \$509 over the 1970 vehicle. A fuel-injection engine with catalysts will also meet this standard at a cost of \$352. Thus, unless the diesel is widely accepted, the cost of reducing NO_x from 2.0 to 1.0 grams per mile is substantial even in the 1980's.

The US78 standard, with NO_x at 0.4 g/mi, costs \$548 for a fuel-injection engine with a three-way catalyst, or \$671 for an engine with mechanical fuel injection with a three-way catalyst. If these data and configurations are accurate, it appears that in the longer run the I77 standards can be met at very little cost, while costs rise rapidly from that point to the 0.4 NO_x level.

If these are reasonable estimates of technology and of its cost, that could be available in the early 1980's, then it appears that the I77 standards can be met in those years at little cost compared to a car meeting 1970 standards. Only changes from the 2.0 g/mi NO_x standard to the final 0.4 NO_x standard impose a real cost penalty.

This analysis suggests that there are two major issues in evaluating emissions standards: time and the final NO_x level. It suggests that in the long run, substantial control can be achieved at a moderate cost. The larger costs which have been and probably will be associated with emissions control may stem not only from strict standards, but from their rapid application. Already there is 1975 hardware which is less costly over the vehicle life than 1973 hardware, despite lower emissions of the former. Thus, it is most meaningful to ask: What would it cost to meet a given standard in a particular year? Industry's ability to develop and put into production new and more efficient technology is a very important factor in determining emissions-control costs.

Another way to view these data is to consider how much the costs for meeting a standard change over time as new hardware is brought into large-volume production. Table 5-4 is a rearrangement of the earlier data, showing different configurations for standards from I75 to US78. The cost per car of meeting I75 standards drops from $265 in 1975 to zero in the early 1980's. (While the cost of the stratified-charge or diesel engine is less than the 1970 car, the savings could occur independently of pollution controls; so they cannot be attributed to controls alone.)

Greater cost reductions might occur for the I77 standard. It may cost $473 to meet this standard in 1977, but $0 in the early 1980's. The T277 standard costs $844 if introduced in 1978, but only $352 by the early 1980's, and $0 if the diesel is used. Even the US78 (0.4 g/mi NO_x) standard, which costs $844 if introduced in 1978, could drop by $300 by 1980, although the current data do not show any reduction after that. Thus, the greatest effect of time on the standards is for the I77 and T277.

The above cost calculations are for a single Intermediate-A vehicle. The production of all vehicles from 1970 through 1985 were also simulated, meeting sets of emissions standards specified in the scenarios. These scenario cost calculations provide an estimate of the total national cost of emissions controls for a variety of scenarios. The average cost per car of a given configuration in these scenarios should be about the same as that used in the single-car cost calculations above. Some differences in total costs may arise because of calculation procedures, but the input data is the same. The configurations are those used in the single-car cost calculations above.

Table 5-4

Single-Car Costs of Delaying Standards
(Lifetime Cost Increase Over 1970 Intermediate-A Vehicle, 1974 Dollars)

Stand	Year	Config-[1] uration	List Price	Life Main- tenance	Life Fuel		Life Total		Present Value[2]
					Tax	Ex Tax	Tax	Ex Tax	Tax
I75	1975	39 Cat.	109	100[3]	56	76	265[3]	285[3]	203
	1980-85	214 Strat.	201	13	-465	-335	-252	-122	-94
		193 Diesel	131	-75	-955	-773	-899	-717	-533
I77	1977	53 Cat.	176	113[3]	184	178	473[3]	466[3]	361[3]
	1980-85	214 Strat.	201	13	-465	-335	-252	-122	-94
		193 Diesel	131	-75	-955	-773	-899	-717	-533
T27	1978	74 Dual Cat. System	302	75[4]	467	401	844[4]	778[4]	694[4]
	1980-85	137 EFI	284	13[5]	56	76	352[5]	372[5]	327
		200 Diesel with EGR	149	-25	-633	-524	-509	-400	-277
US76	1978	74 Dual Cat.	302	75	467	401	844[4]	778[4]	694[4]
	1980	144 EFI with 3-Way Cat.	359	38[6]	152	152	548[6]	548[6]	479

Cat. = Conventional engine with catalytic reactor

EFI = Electronic Fuel Injection with 3-way catalyst

Strat. = Stratified-charge engine with mechanical fuel injection

---

[1] All vehicles are Intermediate-A cars; see Table 3-2 for description of each configuration.

[2] Lifetime total cost discounted at 15%.

[3] Catalyst replacement at 50,000 miles would add $114.

[4] Catalyst replacement at 50,000 miles would add $312.

[5] Catalyst replacement at 50,000 miles would add $156.

[6] Catalyst replacement at 50,000 miles would add $135.

These scenario cost calculations provide more reliable estimates of the costs of standards over time, and of the rate at which alternative technologies can be introduced.

Table 5-5 shows the costs of pollution control from 1970 to 1985 for those scenarios designed to investigate the costs of alternative final emissions standards. The numbers in the first four columns are the sum of the costs incurred in each year, without discounting. The last column shows the present value of these costs in 1970, when discounted to that year at a 4% rate.

Surprisingly enough, the second most expensive scenario is B, which applies no new standards after 1973 yet costs $46.8 billion more than Scenario A. The major reason for this high cost is fuel costs greater than those of all the other scenarios. Such high fuel consumption arises from an assumption that with no new standards after 1973, the same vehicle classes would be built until 1985. Yet, Table 5-1 shows that the 1973 cars use substantially more fuel than vehicles designed to the I75 standards, and thus cost $500 more over their lifetime than the I75 cars.

This comparison is probably not fair to Scenario B. Since the technology has been developed for the I75 vehicles, and it is less expensive over the life of the vehicle than the 1973 technology, reasonable motorists would prefer the I75 vehicle to the 1973 vehicle, and reasonable manufacturers would build the I75 vehicle even without the I75 standard, once that vehicle was developed. Or, they would use the knowledge developed by 1975 to design a vehicle which meets the 1973 standards with total costs still lower than the I75 vehicle. In either case, the B scenario would produce costs much lower than shown here, and perhaps lower than the C scenario. Costs might not be equal

TABLE 5-5

Total Scenario Costs of Various Standards: Scenarios A-E, J (Billions of 1974 Dollars, Costs Increase Over Scenario A)

		Costs ('74$) 1970-1985			
Scenario	List Price	Mainte-nance	Fuel	Total	Total Discounted to 1970 at 4% ('74$)
A	0	0	0	0	0
B	2.6	14.0	30.2	46.8	31.7
C	16.9	8.5[1]	9.4	34.8[1]	24.3
E[4]	21.3	8.2[2]	16.0	45.6[2]	31.1
J[4]	34.7	8.9[3]	24.8	68.4[3]	45.6

---

[1] Catalyst replacement at 50,000 miles would add $10.8 billion for the 95.2 million cars built between 1975 and 1982, at $114 per vehicle.

[2] Catalyst replacement at 50,000 miles would add $12.0 billion for the 95.2 million cars built between 1975 and 1982, at $114 and $156 per car.

[3] Catalyst replacement at 50,000 miles would add $15.3 billion for the 95.2 million cars built between 1975 and 1982, at $312 and $135 per car.

[4] The final technology in Scenario E is Vehicle Class 50. In Scenario J, the final configurations are vehicle classes 71 (Dual Cat.) and 141 (EFI with 3-way catalyst).

to or lower than the C scenario only if the B scenario meant that no standards were even contemplated after those for 1973, and thus, little technological progress occurred without the spur of the I75 and later standards. It is, of course, quite difficult to predict what would happen in this hypothetical case.

Scenarios C,E, and J show steady increases in the list price of cars built between 1970 and 1985. Maintenance costs drop after Scenario B, and are reasonably constant in the other three scenarios. Fuel costs which drop dramatically from B to C, increase substantially from C through E. The undiscounted total scenario cost increases by $10.8 billion from C to E, and by $22.8 billion from E to J. This confirms the conclusions of the single-car analyses that the largest cost differences occur in reducing NO_x from 2.0 g/mi to 0.4 g/mi. In fact, one third of the excess cost of the J scenario over the A scenario is accounted for by the difference between E and J, the difference in cost between achieving 2.0 g/mi and 0.4 g/mi of NO_x.

The direct calculation of the scenarios does not include catalyst replacement for any cars. If the catalysts were replaced at 50,000 miles in all catalyst-equipped cars (assuming the entire unit must be replaced), the cost of Scenario C would increase by $10.8 billion, the cost of Scenario E would increase by about $12 billion, and J would increase about $15.3 billion. Thus, policy decisions on catalyst replacement have a large cost impact; they could add 30% to the cost of Scenario C, and add 20% to 25% to the costs of Scenarios E and J.

When the scenario costs are discounted to 1970 at a 4% rate, total costs are about one third lower than without discounting. The reduction is about proportional for all scenarios, and their rank ordering does not change.

Table 5-6 shows the costs in the year 1985, for the same set of scenarios represented in Table 5-5. This year is chosen for comparison because by that year most of the cars in the fleet meet the most stringent standard in the scenario. It thus represents an equilibrium cost level, assuming no further technological change. Scenario B is still the second most expensive at \$5.06 billion per year. Again, this reflects the unrealistic assumption that 1973 cars would be produced until 1985 in Scenario B.

Scenario J is 70% more expensive than Scenario E in 1985, although its total cost in over the 15 years from 1970 to 1985 was only 50% more expensive (see Table 5-5). This confirms the results of the single-car comparison that, over time, the I77 standard will become relatively inexpensive as better technology is developed, but that the US78 standard will remain expensive.

The single-car calculations in Table 5-1, however, showed lifetime costs of \$844 per car for the US78 standard. This should amount to almost \$10 billion per year for 114 million cars by 1985, yet Table 5-6 shows only \$7.91 billion in 1985 for Scenario J. The reason for this difference is that better technology is developed over time for meeting the 0.4 g/mi NO_x standard, as shown in Table 5-3. By the early 1980's, a configuration is available which meets the standard for only \$548 in lifetime costs. Since this less expensive vehicle comes into production before the more expensive one has become a large part of the vehicles in use, the average cost for all vehicles in use never reaches the \$844 level in any year, even in Scenario J.

5.2 Cost Changes from Delaying Standards

The preceding sub-section examined the costs of achieving several different final emissions levels, on a particular schedule, at a single

TABLE 5-6

1985 Scenario Costs of Various Standards: Scenarios A-E, J

(Billions of 1974 Dollars, Cost Increase Over Scenario A)

	Costs in 1985			
Scenario	List Price	Maintenance	1985 Fuel	Total ($)
A	0	0	0	0
B	0.24	1.54	3.29	5.06
C	1.73	0.78[1]	0.50	3.01[1]
E	2.28	0.72[2]	1.67	4.68[2]
J	4.13	0.84[3]	2.94	7.91[3]

---

[1] Catalyst replacement at 50,000 miles would add about $1.5 Billion.

[2] Catalyst replacement at 50,000 miles would add about $1.6 billion.

[3] Catalyst replacement at 50,000 miles would add about $2.7 billion.

time. In this sub-section, the different timetables for imposing a given set of standards are investigated, since the previous analysis suggested that costs could change significantly over time.

While a single-car analysis is useful for determining the long-run equilibrium costs of alternative final emissions standards, it is less useful for choosing among alternative timetables. The single-car calculations use costs based on efficient volume production with production difficulties worked out. They compare configurations as if one standard would be met by a single technology and another standard, perhaps a year or two later, by a quite different technology. Some of the major differences in various timetables, however, arise from the need to build or convert plants rapidly, and to phase in production or new equipment while working out production problems. There are real production constraints on the rate at which one technology can be substituted for another. Only through the scenario analysis (using the production and investment programs described in Appendix L) is it possible to determine what volume of a given configuration could be produced in each year. Thus, only the scenario results are presented here.

Scenarios I,J, and K represent three different timetables for reaching the 0.4 g/mi NO_x standard. The costs for these scenarios are shown in Table 5-7. Scenario J is the current law, applying the final standard in 1978, with costs which were shown in Table 5-5. Scenario I advances both the I77 and US78 standards by one year to 1976 and 1977. This represents the law as it stood in 1973. Scenario I costs \$3.88 billion more than Scenario J, with the difference composed of equal parts of list price and fuel consumption. Both scenarios build the same vehicle classes, so the cost of differences result from a one-year delay in building the more expensive I77 and US78 cars.

TABLE 5-7

Scenario Savings from Delaying Standards: Scenarios I, J, K

(Billions of 1974 Dollars, Excess Over Scenario A)

Total 1970-1985 Costs

Scenario	List	Maintenance	Fuel	Total
I	36.51	8.95	26.82	72.28
J	34.73	8.88	24.80	68.40
K	33.43	8.52	19.53	61.47

In Scenario K, the US78 standard is delayed until 1980. In addition, a new vehicle class, incorporating mechanical fuel injection with a three-way catalyst, is used to meet this standard when it is introduced. This scenario saves $6.93 billion over Scenario J, consisting largely of the saving from a two-year delay in meeting the 0.4 g/mi NO_x standard, and partly from the substitution of the mechanical and electronic fuel-injection classes for Catalyst Class 71 after the standard is imposed.

The total savings from a delay of standards such as that shown in Scenario K depends on what the automobile industry does during the delay. If it is clear that the standard will be applied ultimately, the industry may use the time to develop more efficient technology for meeting that standard, resulting in lower costs in the future. This development may actually proceed faster than if the standard were imposed earlier, because energies are not diverted to development of an inefficient interim technology. If, on the other hand, it is believed that the standard may be abandoned before it is scheduled to take effect, no development may take place. It is difficult to forecast perceptions of a scheduled standard and, thus, to predict its effect. We have followed a conservative approach here, assuming that the delay would be used to develop a modest amount of new technology.

5.3 Cost of Alternative Technologies

The cost calculations in the previous sections used technological combinations and configurations which may be produced by the auto industry. In the scenarios, attempts were made to calculate the cost of the most likely outcome of any particular standard. Here consideration is given to whether some mix of technology other than that most likely to be used would result in lower costs or a different distribution of costs among the components. Three technologies are considered: the stratified-charge engine, the diesel engine, and fuel-injected engines. All of these may be produced in some measure by the auto industry over the next decade; this analysis increases their market share and compares their costs with the conventional Otto-cycle engine for each of several standards.

Table 5-8 shows the single-car costs of these alternative technologies for several standards. Many of these technologies will not be available at the time the standard is originally introduced. Thus, we are considering cost differences at such time as the alternative technology could be produced in substantial volume, which could be the early 1980's.

The first part of Table 5-8 compares the two primary technologies for meeting the I75 standard with a diesel engine, which easily meets that standard. While Configuration 39, with an oxidizing catalyst, has a higher list price, and uses more expensive unleaded fuel, its maintenance costs and fuel costs are lower than those of the non-catalyst Configuration 32. The unleaded gasoline and electronic ignition system on 39 substantially reduce ignition maintenance, and unleaded gasoline also reduces maintenance on other engine and exhaust components. The catalyst allows tuning the engine for more power and economy so that the higher gasoline price is more than offset by lower fuel consumption. The lifetime cost of the catalyst system is $400 less than the non-catalyst configuration, and $300 less with replacement at 50,000 miles.

The diesel engine saves $899 over the 1970 vehicle, and more than $1,100 over the catalyst configuration meeting the I75 standards. It saves more than $1,300 over the catalyst-equipped car meeting the

TABLE 5-8

Single-Car Costs of Alternative Technologies

(Lifetime Cost Increase Over 1970 Intermediate-A Vehicle, 1974 Dollars)

Standard	Configuration[1]	List Price	Life Maintenance	Life Fuel		Life Total		Present Value[2]
				Tax	Ex Tax	Tax	Ex Tax	Tax
I75								
OC, EGR and Cat.	39	109	100[3]	56	76	265[3]	285[3]	203
OC, EGR only	32	74	325	269	210	668	609	436
Diesel	193	131	-75	-955	-773	-899	-717	-533
I77								
OC, PEGR and Cat.	53	176	113[3]	184	178	473[3]	460[3]	361[3]
SC with MFI	214	201	13[3]	-465	-335	-252[3]	-122[3]	-94[3]
Diesel	193	131	-75	-955	-773	-899	-717	-533
US78								
Dual Catalyst	74	302	75[4]	467	401	844[4]	778[4]	649[4]
EFI and 3-way Cat.	144	359	38[5]	152	152	548[5]	548[5]	429[5]
SC with Thermal Reactor	95	148	225[3]	1,591	1,288	1,964[3]	1,661[3]	1,312[3]

Cat. = Catalytic Reactor

---

[1] All vehicles are Intermediate-A cars; see Table 3-2 for description of each configuration.

[2] Lifetime cost discounted at 15%.

[3] Catalyst replacement at 50,000 miles would add $114.

[4] Catalyst replacement at 50,000 miles would add $312.

[5] Catalyst replacement at 50,000 miles would add $135.

I77 standards. If these figures have any validity, the diesel would seem to be the technology of choice not only for meeting these two emissions standards, but for any less strict standard.

But even if greater consumer demand for diesels were apparent, it is not clear that they would be produced in North America given present pollution-control laws. The large investment in tooling and plants to produce a new engine would only be made by the industry if there were a prospect for a significant market for perhaps a decade, so that the investment costs could be allocated over a large number of vehicles. Yet the diesel will not meet the 0.4 g/mi NO_x standard, and only with exhaust-gas recirculation would it meet the 1.0 g/mi NO_x standard. Thus, it is not likely to be produced at all unless legislation does not require NO_x levels below 1.0 g/mi. If a final standard were relaxed from 1.0 to 2.0 g/mi NO_x, the probability of domestic diesels being produced would increase.

Table 5-8 shows results for a stratified-charge engine for the I77 and US78 standards. For I77, the stratified-charge with Mechanical Fuel Injection is $725 less expensive than the catalyst car, not counting the cost of catalyst change. Since this does not have any of the diesel's disadvantages, it would seem the dominant system for an I77 law. When applied to the 0.4 g/mi NO_x standard, however, another stratified-charge engine is $1,120 more expensive than the conventional engine with catalysts. The fuel consumption of this engine has been greatly increased in adapting it to meet the 0.4 g/mi NO_x standard, rendering it more competitive with other alternatives. It is still more expensive than the fuel-injection system which appears dominant for the US78 standard. This suggests that the manufacturers' choice between fuel-injection and stratified-charge would depend upon their expectations as to the final NO_x standard to be applied. Setting a strict standard may eliminate a configuration which would be highly desirable at some intermediate standard, since it is uneconomic to produce any engine for only a year or two. It also suggests that no single technology is a panacea for all problems. While it makes good sense to include many technologies in cost calculations which are a basis for choosing a set of standards, it would probably be a mistake to legislate in favor of any single technology; there are too many variables and too much chance for future cost or performance changes.

The relative costs of alternate technologies not included in the normal scenarios have also been investigated in a set of modified scenarios. The modified scenarios use the standards of Scenario E, which limits NO_x only to 2.0 g/mi, allowing diesel vehicles to meet the standard easily. Three alternate technologies have been examined: stratified-charge with mechanical fuel injection, diesel, and Wankel. In each case, the new engines are introduced at a reasonable rate given an industry decision in 1974 to adopt the engines. There is no maximum rate of introduction of new technology; rather, there are trade-offs. The more rapidly something comes in, the more it costs, the less reliable it is, and the less well it performs. The schedules shown here are reasonable, but not near the conceivable limit, if cost were no object.

Table 5-9 shows the costs of the technological variations on Scenario E. The stratified-charge variation saves $5.49 billion over the life of the scenario, and $1.55 billion in 1985 alone. This is achieved with a market share[1] of 23.3% of new cars in 1980 and 38.2% in 1985. Thus, even a substantial market share results in modest savings for this technology. The saving is small compared to the difference between Scenarios C and E or E and J, and less than the saving from a two-year delay of the 0.4 g/mi NO_x standard.

---

[1] Market shares for the total U.S. market, including imports.

TABLE 5-9

Scenario Costs of Alternative Technologies: Scenarios ESC, ED, EW

(Billions of 1974 Dollars, Compared to Scenario A)

Scenario	List Price	Maintenance	Fuel	Total		Market Share	
						1980 %	1985 %
			Total 1970-1985				
Normal E (Excess)	0	0	0	0			
Stratified Charge	0.445	0.475	-6.36	-5.49	(S)	23.3	38.2
Diesel	0.34	-0.285[1]	-4.08	-4.07	(S)	7.2	11.6
Wankel	-3.56	0.286	2.49	-0.83	(S)	6.1	10.7
			1985 Costs Only				
Normal E	0	0	0	0			
Stratified Charge	0.119	0.099	-1.76	-1.55	(S)		
Diesel	0.05	-0.08	-1.13	-1.16			
Wankel	-0.67	0.064	0.52	-0.09			

S = saving

---

[1] If catalysts were to be changed at 50,000 miles in the normal E scenario, the diesel scenario would save an added $1.2 billion.

The diesel scenario saves $4.07 billion over 15 years compared to Scenario E, and $1.6 billion in 1985. This saving consists almost entirely of fuel conservation, since list prices are higher than in Scenario E. The diesel market share, however, is only 7.2% of new cars in 1980, and 11.6% of new cars in 1985. This explains why the total savings are so small in the face of single-car savings of $800 to $1,100 over other technologies. The savings per car are large, but there are few diesel cars.

It is no accident that the market share of the diesel is so much smaller than that of the stratified-charge vehicle. The stratified-charge engine is quite similar to a conventional engine; most changes are in the head, manifolds, and carburetor. Thus, existing engine lines can be converted to stratified-charge production with some dispatch. The diesel, however, is completely distinct from a conventional gasoline engine. The block, crankshaft, pistons, and virtually all components differ from a conventional engine of similar size. Thus, it can be introduced much more slowly, for a given rate of production investment.

A rather consistent picture emerges from these facts. An engine that is moderately different can be introduced rapidly, but it saves little per vehicle. Introducing an engine radically different from current ones may save much more (because it is so different), but it must be introduced more slowly if investment rates are to be the same. In short, savings may be closely related to the rate of investment. For a fixed rate of investment, a fixed rate of saving can be achieved, regardless of technology. The major question is not what technology will be used, but what rate of investment can be sustained for new technology.

Table 5-9 also shows a Wankel scenario. This saves less than \$1 billion over the life of the scenario, and about \$0.1 billion in 1985. While there is a large saving in list price, this is nearly offset by increased fuel costs. Large investment penalties, not shown here, would further increase total costs. Furthermore, the Wankel, as a radical technological change, is introduced only slowly. These cost differences seem insignificant, and suggest that emissions control costs at the 2.0 g/mi NO_x level are not sensitive to the proportion of Wankel engines in the fleet, or may be increased by the Wankel when investment is fully accounted for.

5.4 Cost of Small-Car Strategy

It has been suggested that if there were a shift to smaller cars, the cost of emissions controls could be reduced. Clearly, the total cost of motoring will be less with smaller cars; the problem is to separate the reduction in control costs from the reduction in total costs. This has been addressed in a crude way with a single-car analysis and on a more sophisticated basis with a comparison of small-car scenarios.

For the single-car analysis, assume that the size of an average vehicle were originally represented by the Intermediate-A vehicle. Suppose that specific public policies, such as tax on vehicle power and weight plus increased gasoline taxes, caused the average vehicle to be reduced in size to a compact vehicle. The question then is: How much is the increase in lifetime cost from stiffer emissions standards reduced by the shift in vehicle size? More specifically, consider the cost of moving from the 1970 U.S. standards to the 0.4 g/mi NO_x standard. The difference in this pollution-control cost for the two vehicle sizes is the control cost saving achieved by shifting to smaller cars.

Table 5-10 shows the reduction in emissions-control costs for a small-car strategy using single-car data. Application of the 1978 standards increases lifetime costs by $738 for a compact and by $844 for an Intermediate-A vehicle. Smaller cars save about $106 per car at the 0.4 g/mi NO_x level.

This problem is better suited to scenario analysis, in which the entire mix of vehicle production can be shifted to smaller sizes. Table 5-11 shows the scenario costs of a small-car strategy, using Scenarios C and J. With the normal car sizes used in all scenarios, moving from Scenario C to J (i.e., from the I75 to the US78 standards) increases the cost of emissions controls by $33.6 billion over the life of the scenario, and by $4.9 billion in 1985 alone. When both scenarios are rerun using the small-car mix described in Table 4-4, the cost increase of J over C is $30.63 billion over the life of the scenario, or $4.34 billion in 1985 alone. Thus, the cost of meeting the standards of Scenario J rather than those of Scenario C is reduced by $2.97 billion over the life of the scenario, or $0.56 billion in 1985 alone. These cost differences are small compared to the differences caused by other policy options analyzed here. In short, emissions-control costs are not very sensitive to vehicle size, given the data used here. A shift to smaller cars can save many billions of dollars, but those savings are independent of pollution-control costs. The savings of small cars occur almost independently of emissions standards, and the cost of emissions controls are almost independent of vehicle size.

TABLE 5-10

Single-Car Study of Reduction in Emissions-Control Costs for Small Cars

(Lifetime Costs Per Car)

	Compact	Intermediate-A
US70 Standard (Class 22)		
List Price	$3,351	$3,992
Fuel	3,571	4,167
Maintenance	500	550
Total	$7,422	$8,709
US78 Standard (Class 71)		
List Price	$3,631	$4,294
Fuel	3,904	4,634
Maintenance	625	625
Total	$8,160	$9,553
Cost increase	$ 738	$ 844
Pollution-control cost saving for compact = $106/vehicle		

Class 22 - Conventional engine

Class 71 - Dual-catalytic reactor

TABLE 5-11

Scenario Costs of Small-Car Strategy: Scenarios C, J

(Billions of 1974 Dollars, Excess Over Scenario A)

	Total 1970-1985 Costs[1]				
Scenario	List Price	Maintenance	Fuel	Total	1985 Only Total
C	16.89	8.55	9.40	+34.80	+3.01
J	34.73	8.88	24.80	+68.40	+7.91
(Increase)				33.60	4.90
C Small Vehicle	-32.57	7.64	-13.83	-38.76	-8.66
J Small Vehicle	-14.61	7.46	- 0.97	- 8.13	-4.32
(Increase)				30.63	4.34

---

[1] With small cars, scenario cost increases from C to J are reduced by $2.97 billion over 15 years, and by $0.56 billion in 1985.

6. INVESTMENT COSTS FOR VARIOUS SCENARIOS

Investment costs are important in understanding the ability of the automotive industry to introduce new hardware to meet emissions (or other legislative) requirements.[1] Investment cost impacts the industry in several ways. First, the investment costs reasonably assigned to different engine systems or technologies determine the relative competitiveness of each. Second, as the average investment per car rises, the amount of new technology being introduced generally increases with an associated mandate for altering production lines and facilities. This increased level of activity and disruption increasingly stresses the rather fixed cadre of experienced operational managers within the industry, and increases the risk of missing production schedules and of introducing poorly made equipment in the field. Third, as the investment per vehicle rises, it begins to approach the limit of total capital investments which has traditionally been available to the industry yearly for building manufacturing capacity for new products. While difficult to estimate precisely, the limit on capital investment of this type for the domestic industry in recent years has been $300 to $400 million, or about $30 to $40 per car. Other new-product innovations besides emissions changes, of course, also compete for this allocation; for example, changes in production facilities to produce more small cars. Finally, the commitment to new production capability must be viewed not only from the total cost in a specific year, but also in terms of the pattern of investment being committed over a period of years. Clearly, some current decisions may bind company investment funds for only a year or so, while others may, in effect, lay claim to these investment dollars for the next decade.

In the current study, investment costs are calculated on both a per-vehicle basis and on a time-phased yearly basis. In the process of obtaining these numbers, investment was calculated for each production resource, such as a transmission assembly line, one by one (see Appendix L). This data is too microscopic and extensive to be reported here, and, hence, is not included in this consultant report. The net effect of all such shifts in resources, however, is reported.

---

[1] It is appropriate to repeat, that in this consultant report, investment in the design and construction of new manufacturing facilities, outfitting them with equipment, and launching the product is addressed. The associated investment in product R and D is not included.

In Table 6-1, the investment costs per vehicle are compared for an Intermediate-A car for the dominant technology meeting progressively tighter emissions standards. Total investment costs per car are progressively more substantial, as one would expect. To meet the US70, US73, C75, I77 standards, in that order, requires equilibrium investments per car of $0, $22, $11.99, $13.30, and $12.60. It should be stated again that these numbers would change somewhat if the individual time-phased scenario plans were changed, but the general trend would be the same. For Scenario J, two systems are equally dominant: Configuration 74 (dual catalysts) and Configuration 144 (EFI with three-way catalysts). Interestingly, although both systems are near the $30-$40 area for the upper-bound cost, $33.77 and $26.88 per car, respectively, the EFI system is only half as expensive in equilibrium price, $9.76 vs. $24.36 per car. Since this cost for EFI is of the same order as the industry has already made to meet the US75 standards, we would indeed expect EFI technology to be strongly competitive, as was assumed in Scenarios I, J and K (see Appendix F).

The investment costs per car for alternative ways of implementing the US78 standard (0.4 g/mi NO_x) are compared in Table 6-2. The production volumes assumed are also indicated in Table 6-2, since investment costs, in the comparisons which follow, are sensitive to production volume. For the dominant system (Otto-cycle engine with dual catalysts), the equilibrium investment cost ranges from $21.54 to $38.50 per car. In Scenario K, where MFI technology is included (Car 151), this carries an investment per car of $15.77, intermediate between Vehicle 74 and Vehicle 144. This justifies the assumption in that scenario that MFI

TABLE 6-1

Comparison of Scenario Investment Costs per Car for the Dominant Technology To Meet Progressive Standards

(All cars are Intermediate-A size. Data for all car sizes are given in Appendix M.)

Scenario	Standard	Serial No.	Vehicle Description	Investment, $/car				1985 Sales (000)
				Principal	Interest	Total[1]	76-79Max[2]	
A	US70	25	OC, Baseline car	0	0	0	0	2,266
B	US73	18	OC, EGR	.21	.01	.22	.36	1,223
C	US75	39	OC, DEGR, HCAT	11.27	.72	11.99	17.97	1,472
C	C75	46	OC, DEGR, AI, HCAT	12.50	.80	13.30	19.99	702
E	I77	53	OC, PEGR, AI, HCAT	11.80	.79	12.60	19.50	2,266
J	US78	74	OC, Dual-Cat. system	22.72	1.65	24.36	33.77	1,133
		144	OC, EFI, 3-way Cat.	8.97	.78	9.76	26.88	1,133

---

[1] Investment per car based on investment recovery over three years production, averaged over the entire scenario. This number is referred to in the text as "equilibrium investment cost."

[2] Maximum investment per car during the years 1976 to 1979 based on investment recovery over three years production. This number is referred to in the text as the "upper-bound cost."

TABLE 6-2

Comparison of Scenario Investment Costs per Car for a Conventional Engine, Dual-Catalyst Vehicle, and a Vehicle with EFI and a Three-Way Catalyst. All Vehicles Are Intermediate-A Cars Which Meet the US78 Emissions Standard.

(Data for all car sizes are given in Appendix M.)

				Investment, $/car				
Scenario	Standard	Serial No.	Vehicle Description	Principal	Interest	Total*	76-79Max*	1985 Sales (000)
I	US78	74	Dual Cat.	20.00	1.55	21.54	34.98	1,133
J	US78	74		22.72	1.65	24.37	33.77	1,133
JSV**	US78	74		32.02	2.34	34.36	42.78	1,510
K	US78	74		26.55	2.06	28.60	32.10	679
KSV**	US78	74		35.57	2.92	38.50	40.69	906
I	US78	144	EFI with 3-way Cat.	8.61	.74	9.35	22.59	1,133
J	US78	144		8.97	.78	9.76	26.88	1,133
JSV**	US78	144		21.48	1.83	23.32	40.06	1,510
K	US78	144		7.91	.86	8.78	22.58	906
KSV**	US78	144		20.63	1.82	22.45	35.96	1,208
K	US78	151	MFI with 3-way Cat.	14.33	1.44	15.77	39.70	679
KSV**	US78	151		25.79	2.33	28.12	49.48	906

---

[*] See footnotes in Table 6-1.

[**] The first letter indicates the pattern of emissions standards to be followed (Table 4-6) and "SV" indicates that the small-car size mix (Table 4-4) was used.

technology would be competitive. In Scenario J (US78 standards in 1978), no MFI was included because we felt it was unlikely MFI technology and EFI technology could both be introduced for mass production by 1978.[2] In Scenario K where the US78 standard is delayed until 1980, however, it was assumed both could be in production by 1980.

It is interesting to note the effect of the small vehicle shift on the investment cost per car in Table 6-2. In nearly all cases, the sales volume for this Intermediate-A car increases by about 50% between normal and small-car scenario versions. Comparing Scenarios J and JSV, the dual-catalyst system (74) increases in investment cost per car slightly less than 50% ($24.37 to $34.36 in equilibrium investment cost). EFI systems with three-way catalysts more than double their investment cost ($9.76 to $23.32) because a substantially higher rate of investment is necessary to produce the additional volume. This would increase the risk of going to EFI technology in the face of a concurrent shift to smaller cars. Taken in total, Table 6-2 shows that the investments associated with the US78 (0.4 g/mi NO_x) standard are of the same order as the total investments per car for new facilities traditional in the industry.

Scenario F1 compares the investments costs per car of bringing in a variety of alternative engine technologies in modest volume, assuming that the NO_x standard were relaxed to 1.0 g/mi in 1978. Data for Scenario F1 are presented in Table 6-3. Many alternative engine systems which simply cannot compete at 0.4 g/mi NO_x are very competitive at 1.0 g/mi NO_x. Ranked in order of per-car-investment costs (Table 6-3), these are: EFI (137), Diesel (200), CVCC Honda (288), and

---

[2] The problems of introducing two or more new technologies in the same time-frame is discussed more fully in the next section.

TABLE 6-3

Comparison of the Investment Costs per Vehicle for Alternative Technologies To Meet the T277 Standard (1.0 g/mi NO_x). All cars are Intermediate-A Size.

(Data for all car sizes are given in Appendix M.)

				Investment, $/car				1985
Scenario	Standard	Serial No.	Vehicle Description	Principal	Interest	Total*	76-79Max*	Sales (000)
F1	T277	137	EFI with 3-way Cat.	5.34	.73	6.08	27.84	679
F1	T277	158	MFI (CCS) with Oxy. Cat.	44.31	2.29	46.60	78.28	226
F1	T277	200	Diesel with EGR**	6.10	.61	6.71	29.37	271
F1	T277	221	Dual-Cat. System	18.04	1.28	19.33	27.42	815
F1	T277	228	Stratified Charge (CVCC)	13.35	.57	13.93	15.42	135
F1	T277	235	Wankel with Dual Cat.	794.91	32.32	827.23	850.63	135

---

* See footnotes in Table 6-1.

** Assumes a diesel engine with high engine-block compatability with gasoline-engine transfer lines.

Dual-Cat. System (221). The associated investments per car are: \$6.08, \$6.71, \$13.93 and \$19.33. Such a ranking is not absolute, but merely indicative, since the particular numbers are sensitive to the production volumes which differ for the various technologies. The CCS system (158) is a weak competitor at best (\$44.60 per car) and the Wankel (235) would appear to be out of the running unless a substantial investment pass-on to customers were possible (\$827.23 per car).

In Table 6-4, comparative investment data on Wankel cars at Standards I77 and T277 (Scenarios E and F) are presented. The risk of introducing new engine technology into the market during a time of rapid change is amply illustrated. Originally, the Wankel was developed for introduction by the U.S. industry in 1970-1972, at a time when performance improvement and weight reduction were major concerns. With the shift in emphasis to fuel economy and emissions as the result of continuance of strict emissions standards and the energy crisis, the Wankel has had a difficult fight for survival. The penalty for better emissions performance, combined with a drop in sales volume, shows dramatically in Table 6-4. For an Intermediate-A car, the equilibrium investment per car increases from \$328.38 to \$827.23 as the NO_x changes from 2.0 to 1.0 g/mi and the volume drops from 339,000 to 135,000 units for 1985.

The total yearly investment for the automotive industry under Scenarios E, F1, J and JSV are presented in Table 6-5. These investments are the incremental investments over those required for Scenario A. Thus, they reflect the relative additional penalties of following the particular condition assumed in a specific scenario.

Table 6-5 shows the progressive investment-cost penalty over the ten years from 1974 to 1983 of tighter emissions standards. For Scenarios E (2.0 g/mi NO_x), F1, (1.0 g/mi NO_x) and J (0.4 g/mi NO_x),

TABLE 6-4

Comparison of Scenario Investment Costs per Car for Wankel Vehicles to Two Different Emissions Standards

(Data for all car sizes are given in Appendix M.)

				Investment, $/car				1985 Sales (000)
Scenario	Standard	Serial No.	Vehicle Description	Principal	Interest	Total	76-79Max	
EW	I77	177	Wankel Subcompact	116.31	3.86	120.18	137.58	440
EW	I77	178	Wankel Compact	241.60	9.01	250.61	330.49	428
EW	I77	179	Wankel Inter-A	317.46	10.92	328.38	354.29	339
F1	T277	233	Wankel Subcompact	726.54	32.14	758.69	773.03	105
F1	T277	234	Wankel Compact	674.27	29.71	703.98	718.66	128
F1	T277	235	Wankel Inter-A	794.91	32.32	827.23	850.63	135

TABLE 6-5

Yearly Investment in New Manufacturing Facilities for Scenarios E, F1, J and JSV

(Incremental Investment Over Scenario A)

Scenario	Investment	Year 74	75	76	77	78	79	80	81	82	83	
E	+	198	109	219	24	48	19	31	21	11	5	
	-	-11	-9	-13	-2	-7	-2	-14	-2	-10	-2	Total
	net	187	100	206	22	41	17	17	19	1	3	613
F1	+	198	109	306	293	272	40	97	45	28	6	
	-	-11	-9	-27	-25	-33	-10	-19	-70	-28	-45	Total
	net	187	100	279	268	239	30	78	-25	0	-39	1,117
J	+	198	107	382	201	163	94	58	41	31	12	
	-	-11	-9	-23	-23	-34	-7	-35	-2	-10	-4	Total
	net	187	98	359	178	129	87	23	39	21	8	1,129
JSV	+	230	151	341	754	468	231	549	70	76	27	
	-	-11	-13	-138	-176	-231	-166	-163	-57	-15	-113	Total
	net	219	138	203	578	237	65	386	13	61	-86	1,814

+ = Yearly investment in millions of dollars
- = Yearly investment recovery in millions of dollars
net = Net yearly investment in millions of dollars

the corresponding investment costs are $613, $1,117 and $1,129 million, respectively. The heaviest years of investment in all cases are the years 1976 through 1978. In terms of the traditional $300 million limit for investment of this type, these three scenarios just stay within this ceiling.

As the investment per car figures showed earlier, the combination of a more drastic shift to smaller cars and the 0.4 g/mi NO_x standard in 1978 substantially increases the total investment costs. In this case, the investment is $1,813 million, just less than twice that for Scenario J ($1,128 million). While it is difficult to say categorically that Scenario JSC is undoable, having as it does an average yearly investment over the ten years of $181 million, it certainly would stress the industry in the extreme, as well as curtail other options for alternative uses of this investment.

Were the NO_x standard held at 2.0 g/mi NO_x as assumed in all E scenarios, the investment costs are considerably lower. In Table 6-6, the costs of Scenarios E, ED, ESC and EW are compared. The total costs are $613, $630, $730 and $868 million, respectively. Diesel investments and stratified-charge engine investments are roughly comparable to those of conventional technology, while Wankel-engine investments are about 50% greater than conventional engine technology. With average yearly investment of $61 to $87 million, the investment costs for all of these alternatives are clearly affordable.

TABLE 6-6

Yearly Investment in New Manufacturing Facilities for Alternative Technologies To Meet 177 Standards

		Year										
Scenario	Investment	74	75	76	77	78	79	80	81	82	83	
E	+	198	109	219	24	48	19	31	21	11	5	
	-	-11	-9	-13	-2	-7	-2	-14	-2	-10	-2	Total
	net	187	100	206	22	41	17	17	19	1	3	613
ED	+	198	132	189	15	41	38	18	58	13	0	
	-	-11	-9	-13	-2	-7	-2	-14	-2	-10	-2	Total
	net	187	123	176	13	34	36	4	56	3	-2	630
ESC	+	198	29	312	27	78	74	74	29	44	9	
	-	-11	-9	-13	-11	-7	-5	-13	-2	-8	-4	Total
	net	187	20	299	16	71	69	61	27	36	5	791
EW	+	242	250	265	123	31	65	31	37	52	30	
	-	-11	-9	-13	-43	-7	-47	-14	-54	-15	-45	Total
	net	231	241	252	80	24	18	17	-17	37	-15	868

+ = Yearly investment in millions of dollars

- = Yearly investment recovery in millions of dollars

net = Net yearly investment in millions of dollars

EDITOR'S NOTE: These changes are to make the conversion in ESC comparable to that done later for ESC-2.

7. DEVELOPMENT, TOOLING, AND MANUFACTURING CONSTRAINTS

Having compared the lifetime costs (Section 5) and the investment costs (Section 6) of alternative engine technologies in the prior section, it is appropriate here to examine the problems of transferring that technology from development into mass production. In particular, the earliest date at which a given technology might be mass-produced is sought, as is some sense of how fast that production can be scaled up. These questions are answered by reviewing the current status of alternative engine technologies, by examining the constraints in introducing each of them, and by reviewing the data on the investment implications of selected combinations of emissions standards and technology.

7.1 Status of Alternative Engine Technologies

The precise status of the development work for various alternative engines, with the associated problems, has been considered in detail in the Consultant Report on Emissions Control of Engine Systems.[1] The task here is to consolidate this detailed information into a schedule which, while recognizing the difficulties and unresolved developmental issues, estimates the earliest practical date for mass production of the various alternative engine technologies. These estimates are summarized in Table 7-1.

The tooling lead times for the various technologies or the time from initiation of the tooling effort to production, are given in Table 7-1. This time is estimated to be 18 months for the dual-catalyst system, 36 months for the fuel-injected, divided-chamber, stratified-charge engine, and 30 months for all other systems.

---

[1] National Academy of Sciences, Washington, D.C., September 1974.

TABLE 7-1

Timetable for the Fastest Transfer of Alternative Engine Technology from Development to Mass Production

	Engine Technology	Phase	Start	Finish
1.	Dual Catalyst	Development	Present	July 76
		Tooling	Jan. 76	Jan. 77
		Production	July 77	----
2.	EFI with 3-way catalyst	Development	Pre-74	July 76
		Tooling	July 74	Jan. 77
		Production	Jan. 77	----
3.	CVCC (Honda)	Development	Pre-74	Jan. 77
		Tooling	Jan. 75	July 77
		Production	July 77	----
4.	Fuel-injected, divided chamber, stratified-charge	Development	July 74	July 77
		Tooling	July 75	July 78
		Production	July 78	----
5.	CCS (Texaco)	Development	Pre-74	July 78
		Tooling	July 76	Jan. 79
		Production	Jan. 79	----
6.	Diesel of imported design, U.S. built	Development	-Completed-	
		Tooling	Jan. 75	July 77
		Production	July 77	----
7.	Diesel of U.S. design, U.S. built	Development	July 74	July 78
		Tooling	Jan. 77	July 79
		Production	July 79	----

The much shorter time for the dual-catalyst system results from e fact that no modifications of the engine itself are required. cilities must be constructed to fabricate the dual-catalyst housing, ssuming both catalysts (plus oxygen getter for certain systems) are oused in one metal unit, or to fabricate separate housings if they are t in one unit. Facilities for manufacturing pellet, monolith or base-tal units must also be provided. None of these are particularly phisticated components, so a minimum amount of time would be required. e 18-month estimate for these dual-catalyst facilities is based partly the industry's recent experience in developing oxidizing catalyst acilities.

A number of other automotive tooling times are quite similar:

1. Vehicle assembly lines, including chassis assembly lines, will require about 20 months;
2. Body assembly lines require about 20 months to design and build the automatic press welders, body bucks, work-handling conveyors, etc;
3. Body press and forming lines require about 15 to 18 months.
4. Engine assembly lines require about 20 months; and,
5. Component assembly lines require 12 to 16 months to design and build.

The multi-station, metal-cutting transfer lines used to manu-acture cylinder blocks, cylinder heads, manifolds, transmission cases, ar-axle housings, carburetor bodies, etc., require two to three years design, install and debug (see Appendix D). Such lines may be everal hundred feet in length with numerous metal-cutting-tool operating ations, and range in cost from $2 million to $15 million. Typical, annual production of such a line is 300,000 units on a two-shift, five-day-per-week schedule, and almost twice that on three shifts and six days per week. All of the emissions-controlled engine systems in Table 7-1, except the dual-catalyst system, would require some new lines of this latter class or major modifications of existing lines. This fact is reflected in the estimated lead times shown in the table.

In developing the data for Table 7-1, it was assumed one of the major U.S. automobile manufacturers had made a major commitment to produce the engine specified, and the earliest date of mass production was then estimated. If two or more technologies were to be brought in together, the engine system given priority by the manufacturer would have the schedule indicated, while lower priority systems would be delayed. It should also be mentioned that at the present time, no U.S. manufacturer is committed to bringing in any of the systems specified on the schedule indicated.

7.2 Constraints on Rapid Introduction of Alternative Engine Technologies

If the American automotive industry were to bring in a new engine technology on the schedule indicated in Table 7-1, it would not be possible to change over to that technology completely in the first year of production. The reason is that several constraints or limitations exist on the rate of production expansion of a new engine technology, which is described below.

The U.S. automotive industry is characterized in its production activity by its sheer size and delicate internal balance of the factors of production. Among the many factors of production which the industry seeks to balance are the following:

1. To keep the production volume in mass production lines balanced. Parts costs are lowest when lines are run near their optimum volume.

2. To keep individual profit centers profitable. The division of the major companies into identifiable profit units has been a major fiscal control strategy, which may occasionally impede the rapid introduction of new technology.

3. To limit warranty costs. Warranty costs per car, which are in the range of $5 for the engine/drive train system, are rapidly increased with even small changes in engine systems reliability because of the large production rates. As few as 6 to 12 field failures in a given particular part are sufficient to trigger strong corrective action.

4. To use proven, experienced manufacturing managers. In auto making, experience is highly valued. Typically, senior manufacturing managers have over 20 years experience in the industry. If the pace of new product and facilities introduction is accelerated, this pool of experienced managers is extremely overloaded, and only a few acceptable managers can be brought in from other industries.

5. To minimize disruption of the vast network of vendors and suppliers. The automotive industry has traditionally used a large number of vendors for the production of small parts and assemblies for which transportation and materials handling costs are relatively insignificant. These parts are made by numerous vendors who, in turn, have a network of suppliers. Large-scale and rapid product changes severely dislocate this network, raise costs, and increase scrap rates.

6. To balance the load on the machine-tool industry. In 1974, nine companies supplied 96% of the metal-cutting transfer lines used by the U.S. auto industry. Since this capability is small, highly

skilled and difficult to expand, it is important that the industry do what it can to balance their requirements on this sector. Table 7-2 describes the capacity of this sector in detail. In this table, it can be seen that in 1974 the automotive industry used 92/260 or 35% of the capacity of this sector appropriate to automotive manufacturing.

7. To invest conservatively in facilities for new product designs. In recent years, the U.S. automotive industry has allocated 300 to 400 million dollars, or $30 to $40 per car, for new production facilities to make products of new design. This investment is, in a sense, speculative, compared to that made to replace plant and equipment for continuing, proven parts and subsystems. From 1970 to 1974, $130 million, or $14.99 per car, of this allocation has been devoted to new emissions-control designs (see Table 7-3).

To question, then, what limits the rapid conversion from current engine technology to an alternative technology, such as diesel engine technology, the complete answer must speak to all seven of these constraints. Recognizing, however, that most of these are difficult to evaluate in detail and that all are interelated, the investment costs of various alternatives will be used as the lead indicator in the following sub-section.

7.3 Alternative Engine Changeovers Studied in Detail

To determine the investment impact of different combinations of emissions standards and engine technologies, a series of hypothetical time-phased production plans (scenarios) were studied. The final emissions standards and the final engine technology used in these scenarios are summarized in Table 7-4 (see Appendix F for more details on these scenarios). All scenarios cover the period 1970-1985 and the

TABLE 7-2

Estimated Capacity of the U.S. Automotive Tooling Industry in 1974

(Tooling here is taken as meaning metal-cutting transfer lines.)

		(Million $)
1.	U.S. Capacity for Making All Types of Metal-Cutting Transfer Lines	335.
2.	Total Capacity Appropriate to Automotive Operations (78% of Item 1)	260.
3.	Amount of Item 2 Exported	46.
4.	Amount of Item 2 Sold to Other Industries	122.
5.	Net Amount Used for Automobiles in 1974	92.

Source: Appendix D.

TABLE 7-3

Emissions-Related Investment by the U.S. Automotive Industry 1970-1974

1.	Total Emissions-Related Investment 1970-1974		$650,700,0[illegible]
2.	Average Investment per year 1970-1974 (Item 1 divided by five years)		$130,140,0[illegible]
3.	Total car production by U.S. builders (including Canadian production) for the U.S. market	1970	7,115,000 cars
		1971	8,676,000
		1972	9,321,000
		1973	9,669,000
		1974	8,625,000 [illegible]t.)
		TOTAL	43,406,000 [illegible]s
4.	Average Emissions-Related Investment per Car 1970-1974 (Item 1 divided by Item 3)		$14.99 per car

* This number can be derived from Table 2-1 by subtracting the $3,300,000 spent in 1968/70 for PCV-valve tooling.

TABLE 7-4

Combinations of Engine Technologies and Standards Studied

Scenario	Emissions Standard	Ultimate Car Classes	Engine Technology	Calendar Year of Introduction	Domestic 1980 Market Share	Domestic 1983 Market Share
A	US70	22	Baseline Car	1969	100	100
C	US75/C75	29	Conventional Engine with Air Injection & EGR	1974	12	12
		36	Conventional Engine with ECR & Oxidizing Catalyst	1974	47	47
		43	Conventional Engine with EGR, Oxidizing Catalyst, and Air Injection	1974	35	35
		50	Conventional Engine with Proportional EGR, Oxidizing Catalyst, and Air Injection	1974	6	6
E	177	50	As above	1974	91	91
		134	Conventional Engine with EFI and 3-way catalyst	1976	9	9
E-2	177	50	As above	1974	100	100
ED	177	50	As above	1974	86	81
		134	As above	1976	5	5
		190	Diesel	1977	12	14
ED-2	177	50	As above	1974	88	83
		190	Diesel	1977	12	17
ESC	177	50	As above	1974	73	59
		85	CVCC with lean thermal reactor	1977	11	14
		211	(CCS) Stratified-charge engine with mechanical fuel injection and oxidizing catalyst	1977	16	27
ESC-2	177	50	As above	1974	73	59
		85	CVCC with Lean Thermal Reactor	1977	27	41
J	US78	71	Conventional Engine with Air Injection and Serial Catalyst System	1977	64	46
		141	Conventional Engine with EFI and 3-way Catalyst	1977	36	54

Source: Appendix F.

final standard is assumed to remain in effect after it is once operative. Also listed in Table 7-4 is the calendar year in which the particular engine technology is assumed to be introduced and the market share it is assumed to have in 1983. While those scenarios are hypothetical, they do use those engine technologies which were deemed likely at a given standard by the Technology consultants, at a time consistent with Table 7-1, and at a rate deemed practical by this Panel of Consultants.

The results of the study of these investment scenarios are summarized in Table 7-5. If the US75 standards were to continue, the average yearly investment rate would drop from the $130 million yearly for 1970-1974 (Table 7-3) to $30 million yearly for 1975-1979. If the I77 standard were introduced in 1977, the yearly investment would be in the range of $77-$89 million yearly for the period 1975-1979. The assumption of emissions standards is much more important than the engine technology assumed, since the conventional-engine scenario (E), the diesel-engine scenario (ED), and the stratified-charge-engine scenario (ESC) all fall in this range. The corresponding scenarios which introduce only a single competitive technology (E-2, ED-2 and ESC-2) have a similar range of average yearly investment ($56-$98 million). In all of these cases, the yearly manufacturing investment is less than the $130 million yearly the industry has already spent, and, therefore, is clearly affordable.

In the case of the two scenarios with the stricter NO_x standards, F1 (1.0 g/mi NO_x) and J (0.4 g/mi NO_x), the average yearly investments for the same five-year period are $183 million and $170 million, respectively. Since these lie between the $130 million spent between 1970 and 1974 and the total available level of $300 million, these scenarios are also concluded to be practical, although expensive. The same conclusions, of course, can be drawn using the per-car costs as the basis for argument.

TABLE 7-5

Annual Investment Costs of Meeting Various Emissions Standards Under the Assumption of Table 7-4

Scenario	Emissions Standard		Yearly Investment, Million $		Dollar/Car Average 1975-1979**
		HC CO NO_x*	In 1975	Average 1975-1979	
A	US70	(3.9/33/6.0)	0	0	0
C	US75	(1.5/15/3.1)	7	30	3.13
	C75	(0.9/9.0/2.0)			
E	I77	(0.41/3.4/2.0)	100	77	8.04
E-2	"	" " "	20	56	5.87
ED	"	" " "	123	76	7.94
ED-2	"	" " "	50	62	6.51
ESC	"	" " "	20	95	9.30
ESC-2	"	" " "	20	98	10.27
J	US78	(0.41/3.4/0.4)	98	170	17.76

---

[*] HC/CO/NO_x emissions given in grams per mile.

[**] Sales of 47,872,000 units are assumed over this period.

The principal conclusion here, then, is that the difficulty and cost of effecting a particular scenario depends primarily on the emissions standards assumed, and much less on the assumed technology. As expected, tighter standards lead to higher investments, but these are affordable even for the 0.4 g/mi NO_x standard. The introduction of competitive alternative engine technologies introduced in 1977-1979, and rising to a market share of 5% to 20% in 1983, is practical and does not greatly alter the total yearly investment.

8. COMMENTS ON ALTERNATIVE INDUSTRY STRATEGIES

In addition to direct-cost information, work with and consideration of the various scenarios provided some additional insights into the impact of the alternative emissions legislation on the automotive industry.

8.1 Shift to Smaller Cars

The shift to smaller cars and its timing is very uncertain ground for industry planners; therefore, should the switch to smaller cars be more rapid than anticipated (by the small-car pattern instead of the normal pattern), what would then be the possible industry attitudes toward emissions?

In Table 8-1, the total new-car dealer sales (total sticker list price) are given for three standard scenarios (C, J and K) and for their small vehicle versions (CSV, JSV and KSV). Comparing C and J in 1980, we see that J provides \$2 billion per year more revenue than C (\$53 vs. \$51 billion) because of the sale of more expensive hardware. Similarly, in the event the shift to small cars was according to the more radical small-car pattern, JSC would provide \$2 billion more revenue to the industry than CSV (\$48 vs. \$46 billion). Note the implicit assumptions that the hardware will meet the 0.4 g/mi NO_x standard (still unproven) and that the 0.4 NO_x hardware has good enough customer acceptance to avoid any drop in new car sales. Even so, if some confidence were to build in these two areas, the stricter standard would then have the effect of giving a much-needed lift to potentially sagging industry new-car sales revenue.

8.2 Catalytic Converters

Based on current knowledge, both catalytic and noncatalytic emissions-control systems continue to be investigated in automotive

TABLE 8-1

Effect of Shift to Small Vehicles and Progressive Emissions Standards on Sales by U.S. Dealers of Domestic Production

	CALENDAR YEAR										
Scenario	75	76	77	78	79	80	81	82	83	84	85
C	45	46	48	48	50	51	53	55	57	59	61
CSV	45	45	45	45	46	46	47	49	51	52	54
J	45	47	48	50	52	53	55	57	59	61	64
JSV	45	45	46	47	48	48	49	51	53	55	57
K	45	47	48	49	51	53	55	57	59	62	64
KSV	45	45	46	46	47	48	49	51	53	55	57

Dealer Sales in Billions of 1974 Dollars

Source: Appendix N.

research and development laboratories. It is important to note, however, that the industry has been forced to introduce catalytic-converter technology to mass production to meet the California and Federal standards in 1975. In addition, all dominant vehicle classes (71, 141 and 148) for 0.4 g/mi NO_x currently use catalytic technology. In 1974-75, the industry will produce both monolith and pellet hardware in volume. But major questions remain such as: (a) is the monolith or the pellet the superior system; (b) will the driving public accept the converter technology without political ruckus; (c) will the government require, and enforce, catalyst change at 50,000 miles, and (d) will an effective base-metal catalyst be developed to permit elimination of platinum? It is clear that it will be both difficult and risky for the industry to move forward with confidence to stricter standards until such data is available. Presumably, adjustments in Federal regulations would consider such data limitations.

8.3 Diesel Technology

Considering the problems of the shift to smaller cars, pressures for fuel-economy improvements and uncertainties in emissions regulations and test procedure, it is not surprising that the industry is not placing high priority on the automotive diesel, in spite of its good fuel economy. In many ways, the uncertainty in emissions standards generally and for diesel in particular becomes a convenient justification for limited work toward introducing automotive diesel engines.

One major move toward promoting diesel development would be to publish a separate emissions regulation and test procedure for automotive diesel engines. This is not unreasonable, since the engine is acknowledged to have special problems with particulates, sulphur dioxide, odor, and noise. Publication of such a separate regulation may well lead to some subsequent diesel entrepreneurship by one of the domestic manufacturers.

8.4 Production Facilities for Fuel Distribution Hardware

At the present time, major efforts have been made by the auto industry to retain the carburetor rather than to change to EFI. Should EFI in time be seen as a desirable replacement for the carburetor in some cars, it is interesting to inquire as to what the major obstacle to be overcome is, in getting from carbureted, serial catalysts to EFI or MFI technology.

In making this analysis, it is relevant to think of the analogous development of the facilities for the pellet oxidizing catalytic converter. The pellet converter permitted substantial decoupling of the problems of engine design and tuning, under-body modifications, pellet development, pellet-coating development, and cannister manufacture. At the same time, it provided an easy evolution into the leading three-way catalyst system. Through this decomposition of the problem, an 11th hour commitment was obtained to make the plant investment.

It would appear that a similar decomposition of the problem would be necessary to get some company to commit themselves to a fuel pumping (or distribution) hardware manufacturing facility. Alternative designs for a pumped fuel-delivery system (MFI and EFI) would need to be rationalized so that any mix of pumps, tubing and nozzles could be made within this facility on a volume basis. With such flexible capacity, an EFI, MFI, CCS and diesel fuel-delivery system could be made, depending on subsequent product decisions. It is interesting to note that the Panel of Consultants visited a fuel distribution hardware plant, which was extraordinarily modern and efficient, that is a potential model for the facility.

9. SUMMARY OF FINDINGS

In completing a study with the detail of the present one, the constant concern necessarily and properly is the completeness, accuracy, and consistency of the detailed data. In the very process of handling the data, certain assumptions and dominant trends assert themselves. For the present work, these were as follows:

A. The manufacturing of automobiles in the United States has proved to be a substantially more dynamic, difficult, and uncertain business in the late 1970's than it was earlier in the decade. The change has been the result of the compounded effects of government regulations for safety and emissions (and potentially, gas economy), the energy crisis, materials shortages, and the pressures for serious development of alternative engine technologies.

B. In spite of an industry investment for emissions in excess of $300 million per year on research and development and approximately $200 million to $300 million yearly for new manufacturing facilities, the solutions used through model year 1974 to reduce emissions have also been extremely costly to the American driving public. This penalty has been exacted by a 10%-15% reduction in gasoline economy over that of 1970 cars.

C. The oxidizing catalytic converter, which has now been design rationalized and tooled for mass production, substantially eliminates in 1975 model year cars the earlier fuel-economy penalty. Public acceptance of the catalytic converter is a major unanswered question which will depend strongly on the durability of production units in the field, the consequences of occasional converter burnout, the government position on enforcement of catalyst replacement at 50,000 miles, and the speed with which effective base-metal catalysts can be developed.

D. One dominant short-term automotive concern from 1975 to 1980 will almost certainly be the shift to smaller cars with improved gasoline economy. In the present study, it is shown that this shift is extremely cost effective, saving the driving public in total approximately $12 billion each year by the mid-80's, as well as conserving gasoline. The extent of the shift that will occur naturally is an open and difficult question. Fortunately, for the purposes of this study, the scenario comparisons suggest that the question of the optimum NO_x emissions level can, to a first approximation, be considered separately from the small-car shift issue.

E. If the current law is followed, requiring 0.4 g/mi NO_x in 1978, vehicles meeting that standard in that year may cost about $850 more over their lifetime than vehicles meeting a 1970 standard. Total national automobile-pollution-control expenditures could reach almost $8 billion per year by 1985 if no catalyst changes are required, and $10 to $11 billion if all catalyst vehicles are required to change catalysts at 50,000 miles.

F. If the most stringent standard requires only 2.0 g/mi NO_x instead of 4.0 g/mi, vehicles meeting that standard may cost about $475 more over their lifetime than vehicles meeting a 1970 standard. Total national automobile-pollution-control expenditures could reach $4.7 billion per year without catalyst changes, and $6 to $7 billion per year with complete catalyst change. Thus, adoption of a 2.0 g/mi NO_x standard in place of 0.4 g/mi NO_x would save over $22 billion by 1985, and save over $3 billion per year about 1985.

G. Although no emissions technology or system has clearly demonstrated its ability to meet the US78 (0.4 g/mi NO_x) emissions standards, all systems under serious development use the catalytic converter either serially or with closed-loop controls. Consequently, their long-term cost effectiveness is closely tied to the resolution of the unanswered questions regarding converters cited in Sub-section C above. While all such systems are inherently more complex than those used to meet US75 standards, none pose any solvable problems in being design-rationalized and tooled for mass production.

H. Because the manufacturing capacity is largely in place and field history is being generated, the industry is most likely to proceed with a serial catalyst system (such as the Gould system) if the 0.4 g/mi NO_x standard is retained. Other systems with superior fuel economy, such as the electronic-fuel-injection systems, would probably be introduced in time. The combination, however, of a changing industry environment, a domestically unproven technology, limited reliability and field experience, a substantial new investment and reinvestment in production facilities, and an intensified stress on experienced management talent at the operational level provide strong deterrents to rapid introduction of even superior engine technologies.

I. Were the US78 NO_x standard relaxed to a level of 1.0 to 1.5 g/mi, a number of other alternative engine technologies would come back into competition, such as diesel, stratified charge (CVCC), and, possibly, Wankel. The introduction of any one or some combination of these is subject to the same problems cited in Sub-section H and also to the requirement of attaining a reasonable production volume over which to amortize the related investments.

J. The capacity of the U.S. machine-tool companies to design, build and install high-volume transfer-line equipment is a major constraint on the rate at which new engine technologies can be reintroduced. The limitation arises from the relatively small size of this transfer-line-manufacturing capacity, its long-term level of commitment to nonautomotive work, its dependence on experienced (and irreplaceable) employees, and its traditional fear of overexpansion.

K. Given that the automotive diesel technology is particularly cost effective, that there is no special incentive for its introduction as noted in Sub-section I, and that it has certain unique problems in regard to particulates, noise and odor, it would appear to make sense to consider a separate emissions regulation and test procedure for automotive diesel cars.

LIST OF APPENDICES

A. Schedule of the Panel of Consultants on Manufacturability and Costs

B. Summary of Industry Answers to Panel of Consultants Questionnaire

C. Vehicle Structure in the Configuration File

D. Tooling Constraints in the Automotive Industry

E. Manufacturing Assessment of Alternative-Engine Technologies

F. Assumptions for Scenarios and Detailed Time-Phased Plans

G. Methodology for Summarizing Yearly Operating Costs

H. Automotive Fuel Cost and Availability

I. Vehicle Fuel-Economy Data

J. Vehicle Maintenance Data

K. Sticker List Price Data

L. Methodology for Calculating Investment Costs for Alternate Scenarios

M. Summary of Investment Cost Data

N. Summary of Yearly Vehicle Operating Costs

APPENDIX A

Schedule of the Panel of Consultants on Manufacturability and Costs

(Compiled by LeRoy H. Lindgren)

Nov. 18, 1973	Lindgren attended planning meeting in Washington, D.C. at National Academy of Sciences.
Nov. 29, 30, 1973	Lindgren attended CMVE meeting in Washington, D.C. at the National Academy of Sciences.
Dec. 1, 1973	Ebner and Lindgren attended a preliminary meeting at Boston University to develop schedules.
Dec. 14, 15, 1973	Lindgren attended CMVE meeting in Washington, D.C. at the National Academy of Sciences
Dec. 26, 1973	Ebner and Lindgren met at Boston University to prepare schedule of appointments.
Jan. 3, 1974	Ebner and Lindgren visited *Popular Science* office of Jan Norbye to review the European technology status of Wankel, diesel, and stratified-charge engines.
Jan. 9, 10, 1974	Panel of Consultants meeting with Maxwell, Lindgren and Ebner to review work statement and schedules.
Jan. 11, 1974	Panel of Consultants meeting with Ebner, Lindgren, Gay, and Maxwell at Boston University to review computer capabilities.
Jan. 17, 18, 1974	Meetings with Ford, Chrysler, and General Motors Automobile Division executives in Detroit (Lindgren, Ebner, Gay, and Maxwell attending) to define the questionnaire requirements and to review the current status of manufacturing emissions-related components.
Jan. 24, 25, 1974	Lindgren, Ebner, Maxwell, and Gay attended CMVE meeting in Washington, D.C. at the National Academy of Sciences. A coordinating meeting with representatives of the Costs Benefits Committee was held on Friday, January 25.
Feb. 3, 4, 1974	Lindgren, Gay, and Maxwell visited Cincinnati Milacron with M. E. Merchant of the CMVE Committee to review the status of transfer-line production capacities.

Feb. 5, 1974	Lindgren, Gay, and Maxwell visited the Cross Mfg. Co. and Holley Carburetor in Detroit with E. Pugh of CMVE to review the production of carburetors for advanced engines.
Feb. 6, 1974	Lindgren, Gay, and Maxwell visited with executives of the Excello Corp. in Detroit to review transfer line designs for production of diesel and Wankel engine components as well as for conventional engine components.
Feb. 7, 1974	Plant visit to Caterpillar Co. in Peoria, IL and Davenport, IA to see the latest production transfer lines for the new V-8 engine for truck applications.
Feb. 8, 1974	Plant visit to International Harvester Co. in Chicago to see the new transfer lines. Gay, Lindgren, and Ebner met with the manufacturing executives.
Feb. 8, 1974	Lindgren and Ebner attended meeting at Universal Oil Products in DesPlaines, IL to review the manufacturing status of monolith and pellet catalytic converters.
Feb. 15, 1974	Lindgren visited the Caterpillar Co. production facility in York, PA which produces computer-controlled manufacturing, testing, and assembly facilities.
Feb. 20, 1974	Gay, Maxwell, and Lindgren visited Gleason Mfg. Co. in Rochester, NY to review the Wankel component transfer line and machine tool manufacturing.
Feb. 21, 1974	Ebner, Lindgren, Gay, and Maxwell visited the GM carburetor plant to review the production of new design carburetors.
Feb. 22, 1974	Ebner, Lindgren, Gay, and Maxwell visited the GM engine production facilities in Tonawanda, NY to review the new engine production planning.
Mar. 4, 1974	Coordinating meeting with Costs Benefits Committee member D. Dewees, CMVE Executive Director E. Pugh, and CMVE Panel of Consultants on Manufacturability and Costs members Lindgren and Ebner at Boston University.

Mar. 5, 1974	Meeting at Rath & Strong in Lexington, MA between Lindgren and Maxwell to review Maxwell's paper on diesel and stratified-charge engines.
Mar. 6, 7, 1974	CMVE meeting in Washington, DC attended by Lindgren, Gay, and Maxwell.
Mar. 26, 1974	Lindgren, Gay, and Maxwell visited Kearney & Trecker in Milwaukee, WI with company executives to review the tooling companies' position in meeting the automotive companies' tooling requirements.
Mar. 27, 1974	Lindgren, Gay, and Maxwell met in Janesville, WI to prepare the automotive and tooling impact tables to produce alternate engines.
Mar. 28, 1974	Visit to Gilman Engineering to see the automatic assembly transfer line tooling for Wankel engines, air conditioners, and air pumps. Lindgren, Gay, and Maxwell attended a meeting with the corporate officers.
April 8, 9, 10, 1974	Lindgren visited Chrysler, Ford, and General Motors in Detroit to review the status of the questionnaires being prepared for the CMVE Panel of Consultants on Manufacturability and Costs.
April 11, 1974	Lindgren and J. John met in Bowling Green, OH to review the configurations and scenarios prepared by the Panel of Consultants on Manufacturability and Costs.
April 23, 1974	Meeting at Rath & Strong in Lexington, MA with Lindgren, Ebner, and Merchant to review Mr. Gay's paper on tooling constraints in automotive transfer line manufacturing.
April 24, 25, 1974	Lindgren, Gay, and Maxwell attended CMVE meeting in Washington, DC to present the Panel of Consultants on Manufacturability and Costs tooling status report.
May 14, 15, 1974	Panel of Consultants on Manufacturability and Costs meeting in Chicago at the Marriott Hotel to prepare the resource data-base estimates as well as the inventory of tooling capacities. Lindgren, Gay, Maxwell, and Ebner attended.

May 21, 22, 1974	Meeting in Washington, DC at the National Academy of Sciences to listen to the foreign automobile manufacturing companies' representatives. Lindgren, Ebner, and Maxwell attended.
May 23, 24, 1974	Maxwell attended the above meeting.
June 3, 1974	Panel of Consultants on Manufacturability and Costs meeting in Detroit with Pugh, Merchant, Lindgren, Gay, and Maxwell to review the Panel of Consultants report status.
June 4, 1974	Meeting with Bendix fuel injection engineers in Detroit in the morning, and the Ford Motor Co. carburetor engineers at Rawsonville, MI in the afternoon. Lindgren, Gay, and Maxwell attended.
June 5, 1974	Panel of Consultants on Manufacturability and Costs meeting with GM manufacturing engineers in Milwaukee, WI to visit their catalytic converter facility. Gay, Maxwell, Lindgren and Ebner attended.
June 24, 25, 1974	Lindgren and Ebner met at Boston University with Pugh, Evans, and Dewees to develop fuel and maintenance data and scenarios.
July 8, 1974	Lindgren and Ebner met at Boston University with Pugh and Evans to prepare final fuel and maintenance data.
July 22, 1974	Gay and Lindgren met at Rath & Strong, Inc. in Lexington, MA to prepare the final investment data for production tooling for the automobile companies.
July 23, 24, 1974	CMVE meeting in Washington, DC at the National Academy of Sciences to present Panel of Consultants on Manufacturability and Costs investments, scenarios and costs. Lindgren, Gay, Ebner and Dewees attended.
July 25, 1974	Meeting in Washington, DC at the National Academy of Sciences with Panel of Consultants on Technology to coordinate configurations, fuel and maintenance and scenario data. Lindgren and Ebner attended.

July 29, 30, 31, 1974	Meeting at Boston University with Pugh and Dewees to complete the configurations and the cost data base. Lindgren and Ebner attended.
August 13, 14, 1974	Lindgren and Ebner attended CMVE meeting in Washington, DC at the National Academy of Sciences.
September 23, 24, 1974	Lindgren and Ebner attended CMVE meeting in Washington, DC at the National Academy of Sciences.
October 17, 18, 1974	Lindgren attended CMVE meeting in Washington, DC at the National Academy of Sciences.
November 7, 8, 1974	Lindgren and Ebner attended CMVE meeting in Washington, DC at the National Academy of Sciences.

APPENDIX B

Summary of Industry Answers to Panel of Consultants Questionnaire

(Compiled by LeRoy H. Lindgren)

The Panel of Consultants on Manufacturability and Costs (hereinafter referred to as the Panel of Consultants on M/C) prepared a manufacturing questionnaire which requested the following information:

1. The engine configurations that are likely to meet the following standards:

	HC	CO	NO_x	Year
I	3.4	39.0	3.0	US/73/74
II	0.9	9.0	2.0	C 75
III	0.41	3.4	2.0	I 77
IV	0.41	3.4	0.4	US 78

   The configuration data sheet contained sufficient component detailed to identify the specific components required for each engine. The Panel of Consultants on M/C requested detailed costs component or by subsystem. The four companies provided subsystem incremental costs over a 1974 baseline. This data was sufficient for the Panel of Consultants on M/C to develop comparative costs to its own estimates.

2. The fuel economy data for each configuration meeting the corresponding standards. The 1973 vehicle configurations were selected as the baseline.*

---

*For purpose of the questionnaire only, all data was subsequently referred to a 1970 baseline, as reported in Appendix I.

3. The maintenance data for each configuration for the fuel distribution and emission subsystems. The questionnaire requested detailed maintenance service intervals and costs at the component level.
4. The investment impact tables for the actual investments made to date and the planned investments for future configurations and alternative engines.

Each of the four U.S. companies responded to the questionnaire in varying levels of detail. Each company explained the meaning of the cost data and some qualified the data as follows:

a. Care must be taken when comparing financial data among automobile companies. Differences in areas such as accounting conventions, exclusion/inclusion of cost categories, planned make/buy patterns, and sourcing of research and development efforts make financial data comparsions between the various manufacturers difficult. Further, there may be substantial differences in hardware approaches among the manufacturers to meet the same emission standards.

b. The costs are each companies' estimate of the retail price for an average car. These data include variable costs, unique long-term average fixed costs which include tooling, facilities, launching and engineering and normal dealer mark-up. Not all companies included profit.

c. These retail values were developed on the basis of cost estimates and may not necessarily reflect the actual price of the vehicle. In the long run, retail prices for emission equipment and alternate engines would have provided a rate of return on the related investment. Some companies included a contingency factor which provides for revision of cost estimates.

d. None of the estimates provide for future economics because of the difficulty at this time of forecasting future model year economic conditions.

In Table B1, the costs for emissions systems and related modified fuel distribution systems as presented by the U.S. companies are summarized. These data are incremental costs over 1974 systems. Since not all 1974 systems were identical, the 1975 costs vary somewhat depending upon the specific configuration offered in 1974 by each company. Table B1 also includes our Panel of Consultants estimates for comparsion with the automobile company data. These are the hardware costs computed at economic quantities. The investment payback as depicted in our investment scenarios add about $4 to $33 to the base sticker price, as indicated in Table B1.

Comparsion of the industry estimates with those of the Panel of Consultants on M/C in Table B1 indicates that the Panel of Consultants numbers being fully discounted for savings due to production learning, whereas, the industry numbers are current estimates which are not discounted for possible (and likely) future production learning.

Data for fuel economy and maintenance returned on the questionnaires were presented in varying degrees of detail, that for advanced systems and alternative engines being especially tentative. This data has been weighted into the fuel economy and maintenance estimates of Appendices I and J, without any explicit presentation here.

Investment data from the questionnaire were also somewhat uneven. By using this data, however, together with information gathered during plant vists and through review of trade publication such as Metal Working News, it was possible to summarize the investment by U.S. industry to date for facilities to make emissions hardware. This composite estimate of investment is presented in Table 2-1, where it can be seen that $654 million has been spent to date. The greater part of this investment was associated with production capacity for oxidizing converters to meet the US75 standards.

TABLE B1

Emission Systems Sticker Price Increases Over 1974 Carbureted
Piston Engine Vehicles with Catalyst Subsystems

Engine Size	U.S. 1975				U.S. 1977				U.S. 1978			
	U.S. Co. Est.	CMVE M/C Panel			U.S. Co. Est.	CMVE M/C Panel			U.S. Co. Est.	CMVE M/C Panel		
		Hardware Estimate	Invest-ment	Total		Hardware Estimate	Invest-ment	Total		Hardware Estimate	Invest-ment	Total
4-cyl. 100 to 150 CID	135	95 96	12 18	107 114	184	137 140	13 19	150 159		250 256	24 33	274 289
6-cyl. 200 to 260 CID	130 165	100 104	12 18	112 122	180 258	152 167	13 19	165 186	287 323	271 293	24 33	295 326
8-cyl. 262 to 450 CID	155 220	133 150	4 7	137 157	220 311	185 213	6 10	191 223	367 498	333 389	19 30	352 419
Scenario Reference	A/C Class 36				A/E Class 50				A/J Class 71			

Notes:
1) Two U.S. companies did not submit data for Federal 1978 Emissions Standards.
2) 1974 baseline vehicle emission system has PCV/fuel evap./EGR/improved carburetor/TSC (spark control).
3) All costs include tooling, equipment, and facilities investments amortized according to company practices. Two companies included profit and contingencies and two companies did not include profit.
4) The two cost figures in each box relate to the upper and lower CID for each engine class.

APPENDIX C

Vehicle Structure in the Configuration File

(Written by LeRoy H. Lindgren)

The Panel of Consultants on Manufacturability and Costs created a vehicle and manufacturing resource data base which include vehicles previously or currently produced as well as the likely or proposed future vehicles equipped with various emission and fuel distribution systems. The modules of data base are:

- The product or component data base from which the vehicle configurations are constructed. This product data base includes the basic descriptive and cost data needed to build up vehicle costs.
- The resource or manufacturing data base which identifies the specific resources required to produce the product or component. This data base includes the cost of introducing a new facility including launching, labor, equipment, and the building for new facilities as well as an estimate of the cost to close a facility, to restore it to saleable condition and transfer it from the automotive sector. The lead time to acquire and install the new facility also included in this data base.
- Product/resource structure file which is used to construct the "where used" tables for the scenarios. This file indicates all of the resources (facilities) that are needed to create each vehicle which may be made in a given scenario.
- The vehicle configuration file which is the detailed listing of the components required for each type and size of vehicle.
- The vehicle file and maintenance file which is the basic source file for the vehicle-in-use applications, such as the yearly operating cost programs. The file includes the fuel usage and maintenance data requirements for emissions and fuel distribution subsystems. Also included are the aging factors for car population, fuel usage and maintenance over the expected life of the cars.

The Panel of Consultants on M/C used the data base of the previous CMVE study as a basic source document. This foundation was then expanded to accommodate the alternate engines, emissions systems, and fuel distribution systems needed for this study and more recent data was added.

The vehicle configuration as used here is illustrated in Figure C1. The car is subdivided into three sub-parts: body, power plant, and chassis; these in turn are divided into 28 smaller subdivisions. The car was deliberately disaggregated in a way which matched the major resources used to produce the product. Then the Panel of Consultants on M/C was able to proceed to compute the significant investments resulting from changes in vehicle configurations as described in Appendix L.

As indicated in Table 3-1, seven vehicle size categories were used.

Mini-compact

> A small vehicle (not currently produced domestically) patterned after European and Japanese designs equipped with 4-cylinder engines ranging from 85 to 120 CID. The weight would range from 1,800 to 2,300 lb, depending upon the accessory equipment added. Domestic companies are considering this size vehicle, equipped with either front or rear wheel drive systems, particularly if the pressure for smaller cars intensifies.

Subcompact

> A relatively new vehicle in the U.S. which is becoming major competition for European vehicles offered in this same size range. It normally is equipped with a 4-cylinder engine, although some U.S. and foreign subpacts are equipped with 6-cylinder engines. The weight would range from 2,300 to 2,600 lb.

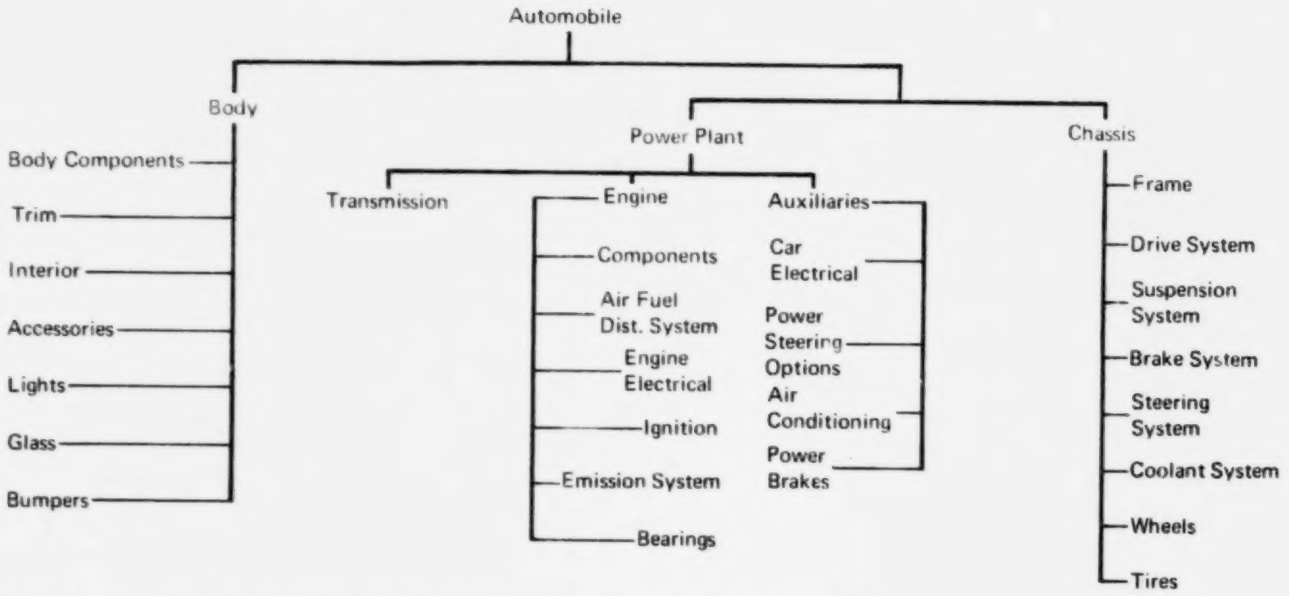

Automobile
Body
Body Components
Trim
Interior
Accessories
Lights
Glass
Bumpers
Power Plant
Transmission
Engine
Components
Air Fuel Dist. System
Engine Electrical
Ignition
Emission System
Bearings
Auxiliaries
Car Electrical
Power Steering Options
Air Conditioning
Power Brakes
Chassis
Frame
Drive System
Suspension System
Brake System
Steering System
Coolant System
Wheels
Tires

FIGURE C1 Standard Pattern of Disaggregation Used in Creating the Product Data Base.

Compact

A small car manufactured in the U.S. designed to compete with those European small cars equipped with higher performance engines. These vehicles are normally sold with 6-cylinder engines, although many are equipped with high performance V-8 engines. With the pressure for improved fuel economy, there are plans to offer these cars with V-6 engines based on European engine designs and in addition to the customary 4-cylinder engines. The weight of this size vehicle ranges from 2,600 to 3,400 lb. There are in limited production expensive specialty vehicles which could be considered as a separate class. But for this study, we considered them in the compact class, since they are built in the same resources used to build the popular compact.

Intermediate

A medium size vehicle manufactured in the U.S. that is equipped with several engines. It is for this reason that two classes of intermediates are considered. The Intermediate A, normally equipped with the 6-cylinder engine or the new 260 CID V-8, could also be equipped with the new V-6 engines. The weight range of the Intermediate A is between 3,400 to 3,600 lb.

The Intermediate coded as INT-B is a higher price medium-size vehicle that is equipped with larger V-8 engines ranging from 300 to 360 CID. The weight of this class ranges from 3,600 to 4,000 lb.

Standard

This full-size vehicle manufactured in the U.S. can vary from medium-priced customs to high-priced fully equipped standards. The engines offered generally range from 350 to 429 CID. The weight varies from 4,000 to 4,500 lb.

Luxury

This class of vehicle is the largest automobile manufactured in

.S. and, when fully equipped with accessories and powered by 440 to 00 CID engines, is the most expensive. The weight varies from 4,500 5,800 lb, depending upon the engine size and other special equipment.

Within these size categories, alternative engine and emissions echnology, as defined by the Panel of Consultants on Engine Systems, ould be specified. The broad classifications of the vehicle technology were as follows:

1. Standard carbureted piston engines.
2. Modified carbureted piston engines with various emission systems required to meet the proposed standards.
3. Electronic fuel-injection piston engines with various emission subsystems.
4. Stratified-charge carbureted piston engines with prechambers and additional valving.
5. Stratified-charge, fuel-injection piston engines with prechambers and various emission systems.
6. Diesel fuel-injection piston engines with pre-chambers (and EGR in some cases).
7. The rotary engine (Wankel) equipped with various emission systems and carbuerated subsystems.

The basic procedure for classifying engines is shown in Table C1. In this Table, eight engine classes, with their nominal displacement values, are indicated. Using this engine classification system, all cars are then sorted into an extended 10 category classification system by engine size, weight and body size in Table C2. The technique used to reduce these 10 sizes to the 7 sizes used in the present study is also indicated in Table C2.

To keep track of a specific car of specified size and technology, a 10 digit numbering system was developed. The meaning of each of the 10 digits is defined in Table C3. This system proved to be very effective in defining the nature of a particular car and in locating it and its associated properties in the computer files. Since the

TABLE C1

Engine Classification System

Engine Class No.	Engine Type	CMVE Nominal Size	Actual CID Range
Class	CYL.	CID	
1	L-4	98	85 - 120
2	L-4	140	121 - 160
3	L-6	250	170 - 260
4*	V-6	160	150 - 200
5	V-8	290	260 - 320
6	V-8	350	321 - 390
7	V-8	400	391 - 430
8	V-8	500	431 - 500

* This engine was available in the data base, but was not used in this study.

TABLE C2

Detailed Scheme for Defining CMVE Car Classes

CMVE Designation		Extended Car Designation										
					Engine Class							
Designation	Nominal Weight	Weight Range	Body Size Code	Car Type	1	2	3	4	5	6	7	8
Mini-compact	2,000	1,800 - 2,300	M	Mini	1							
Subcompact	2,500	2,300 - 2,600	S	Subcompact		2	3					
Compact	3,000	2,600 - 3,300	A	Compact			3	4				
		3,000 - 3,400	A	Compact (Specialty)						6		
Intermediate A	3,500	3,400 - 3,600	B	Intermediate A					5			
Intermediate B	4,000	3,600 - 4,000	B	Intermediate B						6		
Standard	4,500	4,000 - 4,300	C	Standard A						6		
		4,300 - 4,500	C	Standard B							7	
Luxury	5,500	4,500 - 5,000	D	Luxury A							7	
		5,000 - 5,800	D	Luxury B								8

TABLE C3

Details of the Significant Part Numbering System
Digit Within Part Number*

	1	2	3	4	5	6	7		
							Significant Within Engine Type		
Code	Vehicle or Resource	Subsystem	Body Size	Transmission & Drive Type	Engine Type	Fuel Distribution Type	Otto Cycle	Wankel	Diesel
0	0 in a column denotes column is not significant to the number item.								
1	Car	Car	Mini	Manual/Rear	Otto Cycle (not stratified charge)	SSS Turbine Carburetor Fixed Venturi	4 cyl. in line 98 CID	1 Rotor 114 CID	NA
2	Truck	Body	Subcompact	Manual/Mid	Otto Cycle Stratified Charge	SSRG Turbine Carburetor Variable Venturi	4 cyl. in line 140 CID	2 Rotor 226 CID	4 cyl. 165 CID
3	Bus	Engine	Compact	Manual/Front	Wankel (not stratified charge)	SSRC Turbine Fuel Injection	6 cyl. in line 250 CID	2 Rotor 273 CID	6 cyl. 250 CID
4		Transmission	Intermediate	Automatic/ Rear	Wankel Stratified Charge	2SRG Turbine Electronic Fuel Injection	6 cyl. V 160		
5	Plant MFG or ASM	Drive	Standard	Automatic/ Mid	Diesel (not divided chamber)	2SRC Turbine Sonic Carburetor	8 cyl. V 290 CID	2 Rotor Heavy Duty 290 CID	8 cyl. 265 CID
6	Transfer Line	Operating Parameter	Luxury	Automatic/ Forward	Diesel Divided Chamber	Reformer	8 cyl. V 350 CID	4 Rotor 350 CID	8 cyl. 350 CID
7	Vendor	Field Support		CVT	Turbine		8 cyl. V 400 CID	4 Rotor 456 CID	8 cyl. 350 CID
8	Plant--Tool & Die	Engine/ Chassis			Rankin		8 cyl. V 500 CID	4 Rotor 500 CID	8 cyl. 450 CID
9	Refinery								

---

* If the particular unit is a vehicle, the last three positions (8, 9, and 10) would indicate the emissions level; if not, it would contain data on that particular resource.

complete computer outputs and files are too extensive to be included in this report, Table C3 will be of limited directed use to the reader, except as it gives him a better general insight into the methodology of the study.

APPENDIX D

Tooling Constraints in the Automotive Industry

(Written by Hayward A. Gay)

I. Automated Manufacturing

Automated manufacturing flow in an automobile plant involves a very large investment with limited flexibility and long lead time, but it produces masses of similar parts and assemblies at low cost. We describe below the various types of transfer lines that are utilized to perform the major operations.

1. The metal cutting transfer line is a complex multi-station machine tool which extends several hundred feet in length and has numerous metal cutting machine tool operating stations. Each station performs specific operations on a complex part. All cutting stations perform their operations simultaneously on the part located at their station and then retract the tools so that the transfer mechanism may move all pieces simultaneously to the next station.

   Net output ranges from one to two pieces per minute, but there may be as many as 40 pieces in process through as many work stations within the machine.

   Such lines range in price from $2,000,000 to $15,000,000 each depending on the size and complexity of the part and the degree of automation employed.

   Parts produced on such lines include cylinder blocks, cylinder heads, manifolds, transmission cases, rear axle housings, carburetor bodies, pump bodies, etc. The generalized flow of parts in automotive manufacturing is shown schematically in Figure D1.

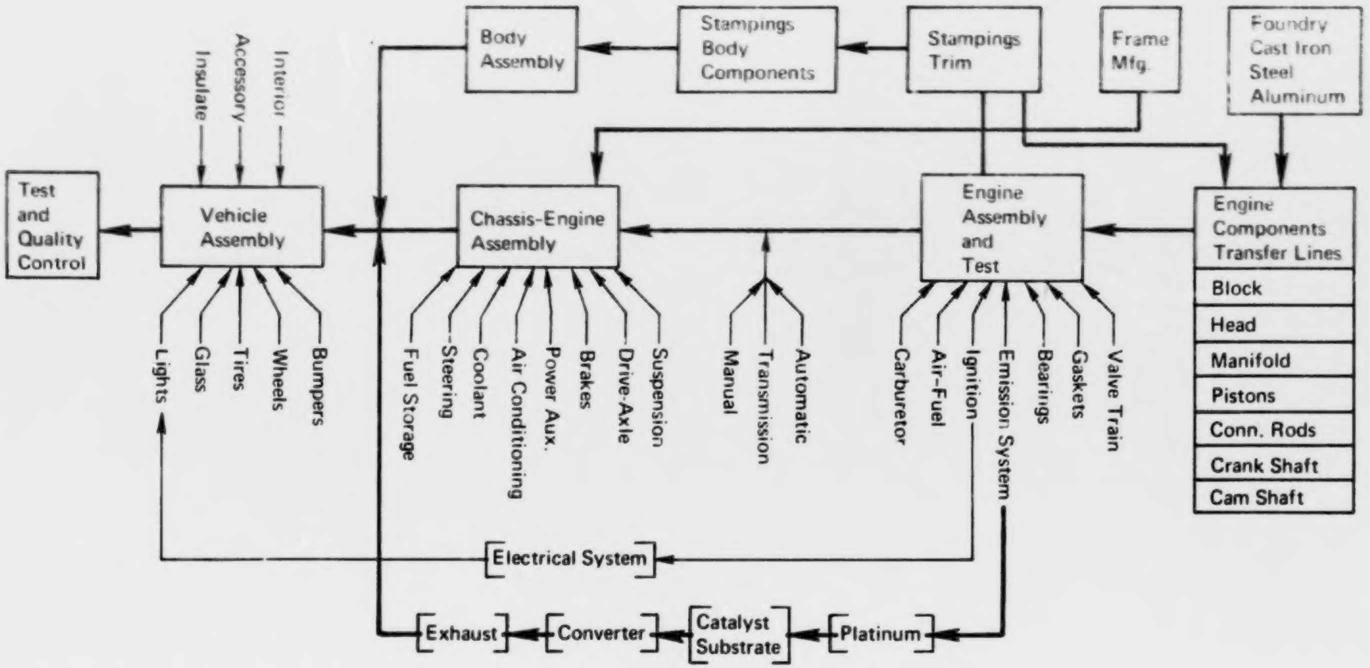

Foundry
Cast Iron
Steel
Aluminum
Engine Components Transfer Lines
Block
Head
Manifold
Pistons
Conn. Rods
Crank Shaft
Cam Shaft
Frame Mfg.
Stampings Trim
Stampings Body Components
Body Assembly
Engine Assembly and Test
Valve Train
Gaskets
Bearings
Emission System
Ignition
Air-Fuel
Carburetor
Automatic
Transmission
Manual
Chassis-Engine Assembly
Suspension
Drive-Axle
Brakes
Power Aux.
Air Conditioning
Coolant
Steering
Fuel Storage
Electrical System
Platinum
Catalyst Substrate
Converter
Exhaust
Vehicle Assembly
Interior
Accessory
Insulate
Bumpers
Wheels
Tires
Glass
Lights
Test and Quality Control

FIGURE D1 Production Flow in Automotive Manufacturing.

2. Automotive transfer assembly lines for power plant components are used to assemble the parts included in a subassembly such as the cylinder head, transmission, starter, carburetor, power steering, air conditioner, water pump, etc. These components are smaller and less complex so the assembly lines are likewise shorter and simpler than would be needed for the main engine assembly.

The body of the assembly is mounted into a fixture which may be indexed to various positions and is attached to a transfer mechanism. The transfer, with multiple fixtures attached, is advanced from station to station on a timed cycle and at each station a part or parts are assembled into the body by hand or automatic mechanism. Automatic inspection is frequently applied at several stations along the line.

3. The engine assembly line ranges from 400 to 800 feet long and starts with the cylinder block mounted in an index fixture on the transfer mechanism. With the block upside down, the crankshaft, main bearings and bearing caps are assembled. Then (with the block on its side) the piston, piston ring and connecting rod subassemblies are inserted into the cylinders from the top side of the block and the connecting rod bearings are bolted around the crankshaft pin bearing diameters. The oil pump and oil pan are also added at this point. Then with the block upright, the cylinder head assembly including camshaft and valve train is added, followed by manifolds, transmission, carburetor, starter, alternator, water pump, fan, belts, distributor, power steering and power brake system, front cover, air conditioner, etc.

The assembled engines are finally put on a test stand for a short run-in and check for water leaks, oil leaks, adjustment of timing, etc. After test and final inspection they are painted and marked for transfer to a vehicle assembly plant.

4. The chassis assembly line starts with the frame of the car mounted on an individual station of the transfer mechanism. As the frame advances along the line, various subassemblies are mounted thereon such as the suspension system including springs and shock absorbers, the rear axle, housing, engine assembly with transmission attached, drive shaft, steering column with linkages, brake system, radiation and cooling system, gas tank, muffler with converter and exhaust pipes, etc.

5. The body assembly line runs in parallel with the chassis assembly line in the same or a separate building. Stampings are welded together in forming or holding fixtures and the unit moves by automatic transfer from station to station until the body structure is complete.

After multiple inspections insure that all doors and deck covers fit properly, the unit goes through a sophisticated paint line. Then it goes to final body assembly where inside and outside trim and seat cushions are installed.

Because of the bulk of bodies which makes storage difficult, they are computer-scheduled by style and color so they can move right off the end of this line and over to the chassis assembly line in proper sequence.

6. The vehicle assembly line may be an extension of the chassis assembly line or separated from it. In any case, this is where the finished body meets the proper chassis as controlled by the sequencing computer. After the body is mounted on the chassis (which now contains the complete drive train), the front fenders, grill, lights, battery, hood, bumpers, wheels with tires, etc. are added and all components wired and interlocked to make the finished vehicle.

Gasoline is added at the end of the line and the car is driven to final inspection where every car is checked in detail before being released for delivery.

II. The Effect of Engine Changes on Manufacturing Facilities

1. To build a small engine of current design to replace a large engine will require new metal cutting machine tool transfer lines for the major parts such as the block, head, manifolds, transmission case, carburetor body, etc., as these parts are of smaller size and difference in configuration. Alteration of existing transfer machine lines is not practical, and in most cases not even possible, with such major changes in part configuration.

Most single-operation machine tools can be converted by minor changes and do not need to be replaced. These include gear cutters, lathes and grinders for transmission internal parts, camshaft grinders, valve grinders, piston and piston ring machines, connecting rod broaching, drilling and boring machines, etc. However, some single-operation machines, such as crankshaft lathes, probably will need to be replaced because the new shafts are smaller and a different shape.

Many dies for forgings, stampings and body parts must be new but can be used on existing presses. The industry capacity for die making has been seriously reduced during the last five years as a result of numerous die-making shops going out of business.

The various assembly lines will undergo considerable modification, but the original transfer system and floor space may be utilized if the small car is replacing the larger model. Since the new car is smaller and simpler, the plant layout and space allocation will be changed considerably. Also, the lines for component assembly will be modified extensively.

2. To change existing engines to the stratified-charge configuration will apparently gain the most in emission control with the minimum of engine and car conversion. It is believed that there would be no important changes to the cylinder block or its assembled parts below the cylinder head face and no change to the transmission, running gear, suspension or body.

The cylinder head, camshaft, rocker arms, valves, manifolds, fuel system and ignition system would probably all involve change. A new transfer line to machine the cylinder head would be the primary expense and the longest lead-time item. Machinery for making the camshaft, rocker arms, valves and manifolds can probably be altered if the new engine is of the same size. New machinery for the fuels and ignition systems depend upon what system is used, but in any event the lead time would not be greater than the cylinder head machine.

The various assembly lines would be unchanged except for the cylinder head subassembly and possibly the fuel system and ignition system subassemblies.

3. To change to a light automotive diesel configuration does not involve new manufacturing technology. Many companies around the world are now making small automotive and medium to large truck diesel engines in volume. However, there would be many changes from existing processes and equipment because the diesel is heavier for a given horsepower and utilizes a different fuel and ignition system.

The small diesel designs could be imported for installation in small American cars with minimum change in the front end suspension and engine compartment. However, to manufacture small diesel engines in quantity would require a major investment in plant and equipment.

The larger diesel engine designs 250 to 450 CID would be new. Hopefully, this could be accomplished by dieselizing the existing automobile engines. If the diesel was approximately the same overall size as the gasoline engine, it would fit the same cars with very little change, although it would be a little heavier and would give slightly less performance.

If we dieselized the existing larger gasoline engines, the block, head, crankshaft, pistons, connecting rods and bearings would be heavier but would generally have the same critical dimensions and in most cases could be made on the existing machine tool equipment with minor alterations. This would save considerably in both investment and lead-time after the design and prototype testing is completed.

The primary objection to the above suggestion is that the existing production line would be shut down for six months to a year to make the tooling conversion. Also, new crankshaft lathes may be required as the diesel may use a forged crankshaft instead of cast. Finally, it will be necessary for someone to tool a high pressure fuel-injection system for mass production in this country.

If the larger automobile diesel engines are to be a wholly new design without regard to existing gasoline engine design, then the capital investment and lead times would be greatly expanded.

Assembly of a diesel engine is not much different than for a gasoline engine of the same size and configuration. It is believed that all assembly lines could be used with minor rearrangement of parts supply, tools and inspection equipment. The carburetor and ignition lines would not be needed and a fuel-injection subassembly line would be added.

4. To change to a rotary engine configuration involves the greatest design, tooling and manufacturing expenditure in both

time and money if the full benefits of this engine are to be realized. Because of the smaller size and lighter weight, optimum benefit is derived only with a completely new body design, new suspension and probably a front-wheel drive with a new transmission.

There are practically no parts or subassemblies in a rotary engine that are similar to the piston engine. Hence, we are confronted with completely new engine manufacturing facilities utilizing many new manufacturing technologies. The generation of the trochoid housing shape with proper metalizing, surface finish, close tolerances, plus the unique side seals and apex seals of the rotor are only a few examples. Designs are not frozen for mass production because there still is much to learn on these matters as well as engine lubrication, combustion, ignition, economy, etc.

Until the economy, durability and low emissions of the rotary engine is developed and proven, multiple production lines for this configuration are not likely to be instituted in the U.S.

III. Impact of Pressure for Fuel Conservation

The automobile industry is making some progress in improving the fuel economy of existing engines while maintaining emission control. However, the primary activity of the industry toward fuel economy is for much more capacity to build small cars with small engines. This involves a major investment for conversion of existing plant and tooling plus additional major expenditures for new transfer lines to produce new engines not now available in this country.

The combination of major new tooling programs for smaller engines, plus the need for tooling programs to make new configuration engines for better emission control, coupled with an expanding machine tool requirement by nonautomotive metal working industries, have made the machine tool industry one of the primary restraints in a rapid conversion to new configuration automobile engines.

IV. The Machine Tool Industry

The characteristics of the machine tool industry should be understood to comprehend better the relationship it maintains with the automobile industry and its manufacturing problems.

The machine tool industry is unique and little understood. It is small in total size and is made up of more than 100 small companies or subsidiaries of larger corporations. Some summary data on the larger of these companies (based on our survey) is shown in Tables D1 and D2.

Prior to 1950, probably 80% of the machine tool companies were privately owned and ranged from 3 to 15 million dollars annual sales volume. The machines were primarily mechanical mechanisms actuated by hydraulic or electric drives and controlled by an operator in full-time attendance. So-called machine lines for machining a large part, such as an automobile cylinder block, in large volume were usually only individual semiautomatic machines connected together by a conveyor and still requiring considerable labor.

Today, since conglomeration, more than half of the machine tool companies have been merged into larger diversified companies. Today's machine tools are more sophisticated with computer controls, automated work handling, in-process gauging, and automatic tool-changing plus greater accuracy and speed.

The technical sophistication of new machine tools provides many advantages for the user, but makes it more difficult to expand machine tool manufacturing capacity rapidly. There is a shortage of skilled engineering and shop personnel, where a lot of art as well as since is concerned. There is frequently a shortage of working capital and a high risk factor on large special machines. Further, the cyclical nature of the business cautions against becoming over-extended.

TABLE D1

Survey of the Automotive Tooling Industry

		A	B	C	D	E
Primary Builders of Metal Cutting Transfer Line Machine Tools	Metal Cutting Transfer Line Est. Capacity All Types 1974	Amount Appropriate to Automobile Type Oper. 1974	% of "A" Exported 1974	Amount Exported $s 1974	% Sold of "A" not for Automobiles 1974	Amount Sold Not for Automobiles 1974
	(million)	(million)		(million)		(million)
A	$60.0	$45.0	15	$ 6.7	50	$20.0
B	50.0	40.0	10	4.0	25	10.0
C	45.0	35.0	20	7.0	70	24.0
D	35.0	30.0	70	21.0	70	21.0
E	35.0	30.0	7½	2.1	30	9.0
F	43.0	30.0	0	0	50	15.0
G	25.0	20.0	20	4.0	25	5.0
H	17.0	12.0	10	1.2	85	10.0
I	10.0	8.0	0	0	35	3.0
All Others	15.0	10.0	0	0	50	5.0
TOTALS	$335.0	$260.0	18%	46.0	47%	$122.0

TABLE D2

Estimated Capacity of the U.S. Automotive Tooling Industry in 1974 in Millions of Dollars

(Summary of Data from Table D1)

1.	U.S. Capacity for Making All Types of Metal Cutting Transfer Lines	$335
2.	Total Capacity Appropriate to Automotive Operations (78% of Item 1)	$260
3.	Amount of Item 2 Exported	$ 46
4.	Amount of Item 2 Sold to Other Industries	$122
5.	Net Amount Used for Automobiles in 1974	$ 92

Most machine tool companies make only a small segment of the various types of machines needed in an automobile plant.

a. At least 95% of the companies who make metal-cutting machines do not make metal-forming machines; the reverse is also true.

b. At least 75% of the companies that make standard or semi-standard metal-cutting machine tools make only one type. Examples of the different types of machines are turning, milling, drilling, grinding, gear cutting, etc.

c. A small group of about 10 companies make only specially tailored transfer lines for completing all machining operations on a complex part, such as an automobile cylinder block or head.

d. Of the approximately 20 companies making turning equipment, only two make automobile crankshaft and camshaft automatic lathes; of the 10 or more companies making precision grinding machines, only two make crankshaft and camshaft grinders.

Total shipments of metal cutting machine tools, as reported by the National Machine Tool Builders Association, peaked in 1968 at $1,358,000,000 and then dropped to a low of $672,000,000 in 1971. In 1973 the industry recovered to $1,074,000,000 and $1,325,000,000 is projected for 1974. This is about the capacity of the industry with existing facilities and operating conditions. It is noteworthy that the entire metal-cutting machine tool industry, so vital to national productive capacity, is smaller than each of the 150 largest industrial companies listed in the last inventory in Fortune magazine.

Governmental policy in 1969 did substantial damage to the machine tool industry. Money was made tight and expensive and the investment tax credit was repealed with the result that capital expenditures just about stopped. The metal cutting machine tool industry backlog dropped to a low of $408,000,000 as of 12/31/71, which was only 31% of the previous peak. This was the greatest percentage drop since the Depression of 1932. The backlog has now recovered to $1,454,000,000 as of 12/31/73. These figures confirm the cyclical nature of this industry.

Today, when the government wants maximum help from the machine tool builders, there are many who are unmoved by the appeal. This is not a lack of patriotism; it is a lack of faith. We are not threatened by war, and the government projected machine tool requirement is subject to sudden change - just as the investment tax credit has been changed several times in 10 years with every new legislative philosophy. The industry will do all it can for its customers, but not many plan to expand their facilities extensively until they are convinced there is long-term justification.

Our survey indicates that most of the builders who have dropped out of the transfer line business do not plan to reenter the business. The risk is too high because of the high unit value of special machines; they tie up too much capital and floor space with low turnover, and regular product lines are selling at capacity.

We have taken the 1974 estimated shipments as the existing capacity of the industry. That segment of the industry which builds special metal-cutting transfer lines for making automobile type parts is estimated to have a capacity of $260,000,000 in 1974 and will probably expand 20% during the next three years to a volume of $312,000,000 in 1974.[*] However, in 1974 about 18% of this volume will be exported and another 47% is sold for heavy diesel trucks, farm tractors, off-highway equipment, stationary engines, etc. This leaves only 35% or $92,000,000, being shipped to domestic automobile companies in 1974 (see Table D2).

If we assume that in two years this ratio can be reversed and 65% of the capacity would be applied to new automobile engine configurations and the industry did expand 20%, we could then project a capacity for chip making transfer lines at 65% of $312,000,000 or $202,000,000.

In our projections of total machine tool capacity to equip the domestic automobile industry for new engines to meet the Clean Air Act, we are assuming that the most capital intensive and longest lead-time equipment items needed would be the large, metal-cutting transfer lines for making cylinder blocks or cylinder heads.

If new crankshaft, camshaft, valve, piston, ignition, fuel control or converter parts, etc. are required, we believe the new machine tool equipment for these items could be acquired within the time necessary for a new cylinder block or cylinder head line. The machine tool equipment for the smaller parts is usually of shorter lead time and made by machine tool builders other than those who make transfer lines.

As of June 1974, order backlogs of transfer line machine tool builders range from 14 to 24 months. The average is about 17 months.

---

[*] Government figures show shipments of transfer lines at $132,600,000 in 1972. Figures for 1973 are not yet published. Total machine tool shipments will increase 86% from 1972 to the estimated 1974 figures; applying the same ratio would indicate 1974 transfer line volume at $246,000,000. This checks very closely with our estimate of $260,000,000 and our slightly higher figure is justified because recent large orders from farm implement and diesel truck customers have probably pushed the special segment of the industry a little faster than the industry as a whole.

This lead time could increase drastically if there was a large influx of automotive orders (or drop drastically if business conditions are depressed). During other periods of urgency, deliveries of this class of equipment have extended to 30 months or more.

After surveying the major builders of large, metal-cutting transfer lines, we belive the average price, including work holding fixtures and tooling, of a line to produce 300,000 pieces per year operating at normal efficiency on a two-shift basis is shown in Table D3. These prices are for metal-cutting machinery only and do not include building space, installation and start-up costs, part washing and inspection equipment, etc.

Another segment of the machine tool industry involves the design and building of automatic transfer assembly machines for subassembly units such as carburetors, pumps, starters, disc brakes, air conditioners, etc. A few builders of metal-cutting transfer lines also build assembly transfer lines, but the majority of such builders specialize only in assembly operations.

Foreign machine tool builders are not potential suppliers of automatic transfer lines for American industry. Their limited capacity is already committed to similar demands of their local industry and exports to the Eastern Block Countries. Further, the American automobile industry has never bought transfer lines from abroad because of the high technical sophistication and complexity of such units, the massive size and shipping costs, the long installation and try-out time and, finally, the continuing supplier service required. It is noteworthy that 97% of the metal-cutting transfer line machines are built within a 400 mile radius of Detroit and most automobile manufacturing plants, except body and assembly plants are in the same area.

Single purpose machine tools such as gear cutters, grinding machines, lathes, etc. can be imported from abroad if technology price and delivery are advantageous. However, since the metal-cutting

TABLE D3

Comparative Costs of Metal-Cutting Transfer Lines To Make Various Types of Car (1974 Dollars)

Metal-Cutting Transfer Line	Type of Car to Be Made Typical 1974 Car	Stratified Charge	Light Diesel
4-Cyl. Head	$ 4,900,000	$ 6,400,000	$ 5,900,000
6-Cyl. Head	6,000,000	7,800,000	7,200,000
4-Cyl. Block	8,000,000	7,900,000	9,400,000
6-Cyl. Block	9,500,000	9,600,000	11,500,000
V-8 Cyl. Block	11,000,000	11,000,000	13,200,000
4-Cyl. Manifold	2,300,000	2,700,000	2,700,000
6-Cyl. Manifold	3,000,000	3,300,000	3,600,000
V-8 Exhaust Manifold	2,900,000	3,100,000	3,600,000
V-8 Intake Manifold	4,000,000	3,600,000	4,500,000
2 Barrel Carburetor Body	1,400,000	2,200,000	--
4 Barrel Carburetor Body	2,000,000	3,000,000	--
Fuel-Injection Pump Body	--	--	3,800,000

transfer line machines have the longest lead times, the single purpose machine tools can usually be obtained in the domestic market in adequate time.

Minor design changes on a part or subassembly can usually be accommodated by minor changes in the automatic transfer line for machining the part or assembling the unit. This is done by modifying the operations at selected stations by changing cutting tool sizes, adding or deleting a whole work station. An assembly machine can be similarly altered within limits.

Primary design changes such as a stratified-charge cylinder head, or a small 4-cylinder block for a subcompact, will require a completely new metal-cutting transfer line since the part size and configuration is quite different and modification of existing equipment would cost as much and take as long to build a new machine and there would be no extensive down time during conversion.

V. Conversion Lead Times

The proper lead time concept is important and involves the magnitude of the manufacturing problems in making a relatively simple engine change such as the stratified charge versus the more complete engine change as in the case of the diesel and finally an even more far reaching change in methods and facilities as would be necessary with the rotary engine.

1. The vehicle assembly line, including the chassis assembly, will require about 20 months to construct and equip with feeder conveyors, tools, stock bins, etc. An existing line could be converted to assemble a different car in four to eight months.
2. The body assembly line will require 20 months to design and build the automatic press welders, body bucks and/or body side "gate" fixtures, plus work handling conveyors, etc. If

an existing line is being converted to a different car, it will still take 12 to 17 months to design and build the new tooling.

3. The body press and forming line will require 15 to 18 months to design and build the stamping presses. The lead time to design and build the body dies ranges from 10 to 24 months depending on the size and complexity of the dies.

4. The engine assembly line is quite complex and would require 20 months to design and build. This includes the transfer mechanism, multiple fixtures, feeder conveyors, parts banks, tools, gages, etc. To convert an existing line to a new engine of similar size would require 6 to 10 months.

5. The component assembly lines, which usually include automatic assembly machines, require 12 to 16 months to design and build. Such lines could be converted to a new design of similar unit assembly in 10 to 12 months.

6. The primary parts manufacturing lead time is probably the greatest of all segments of the automobile manufacturing operations. It costs $8,000,000 to $13,000,000 per transfer line to machine a cylinder block and lead times of 24 to 30 months to design, build, install and debug such a line. Net production would be about 300,000 units on a two shift five-day schedule and about 550,000 units on a three shift six-day basis.

Similar lines for machining manifolds, carburetor bodies, etc. will cost less but still require 16 to 24 months lead time.

7. Lead time for the first lines of new configuration cars is a minimum of three years since it will take 30 months to get the primary metal-cutting transfer line for the cylinder block. This minimum time is after all necessary technology and designs are established. If prototype testing is still involved, we are talking 42 to 48 months.

The lead time of three years is for one facility to produce about 300,000 cars per year on a two shift five-day schedule or 550,000 on a three shift six-day schedule. If several companies wish to establish new lines simultaneously, the machine tool industry might be a limiting factor.

From an efficient operating point of view, the limitation on capital, skilled labor, machine tool capacity and the necessity of proven customer acceptance of the new model, all indicate the necessity of phasing into whatever engine configuration is ultimately found to be most desirable.

8. Lead times for total industry conversion to a new engine configuration is a variable figure due to variations between companies and variations between several engine configurations.

Considering the various limitations and present state of the industry technology, we have established an industry wide conversion time table as follows:

Each automobile company to complete technological development and one production facility for:

Stratified-charge engine - 4 years
Light diesel engine - 5 years
Rotary engine - 6 years

The complete automobile industry to complete conversion of all car and light truck engines to a new configuration in four basic sizes and a volume of 15 million engines per year to:

Stratified-charge engines - 10 years
Light diesel engines - 12 years
Rotary engines - 14 years

VI. Current Industry Status

Current industry progress in converting to new configuration engines seems to still be primarily in the development and prototype stage. All cars through the 1976 model year will be the conventional piston engines with air injection, exhaust gas recirculation and oxidizing catalytic converters.

The stratified-charge, or prechamber, engine seems to be the most accepted next step in meeting the emission standards, and all companies are working on one or more versions. The Honda configuration seems to be preferred because it is simpler and cheaper to manufacture. This engine is favored as an intermediate and possibly as a final solution to the problem. It is preferred because it gives good driveability and emissions performance with minimum change to the engine - only from the cylinder head gasket up! However, at this date we know of no machine tool orders which have been placed to machine prechamber cylinder heads.

The light diesel technology is well known, but at this date, we do not know of any machine tool purchases to make parts for light duty automobile engines of this type.

Initial production equipment for the rotary engine has been committed by General Motors and most of the machine tool equipment is completed. In our visits, we saw the trochoid housing machines, the transfer line for machining the rotor, an automatic assembly machine for the rotor and seals and a test stand for final run-in. However, delivery is being delayed pending possible engineering changes as a result of continuing research to improve the fuel economy, durability and emissions characteristics of this engine. We do believe General Motors will ultimately market the rotary at a volume of possibly 250,000 per year in an existing car.

Ford and Chrysler appear to have no interest in mass producing the rotary at this time. This observation is based on a complete absence of orders for tooling for rotaries from these companies, so far as we know.

APPENDIX E

Manufacturing Assessment of Alternative-Engine Technologies

(Written by Carl Maxwell)

Overview

Before the advent of emission control legislation, the conventional, spark-ignition automotive engine had been brought to a high state of development with power, smoothness and noise as major criteria. A secondary criterion was fuel consumption. Emissions were not considered at all. As a result, automobile engines underwent gradual changes to meet the laws as they became effective. The changes were principally leaner mixtures at idle, quicker choke opening, elimination of quench areas in the combustion chamber, and a trend toward longer stroke/bore ratios. In some cases, an air pump was added to promote combustion of HC and CO in the exhaust manifold. These changes were quite effective and, with the exception of the air pump, cost the consumer very little in terms of first cost, fuel consumption or performance. Some minor problems with driveability did arise. NO_x was limited for the first time in 1973, starting a trend toward lower compression ratio, retarded spark timing and exhaust gas recirculation (EGR), and leading to a serious reduction in gasoline mileage.

In late 1973, the oil shortage became severe and gasoline prices rose drastically. Major efforts were immediately started to produce cars with better gas mileage. With the tight HC and CO specifications for 1975, most cars will be forced to use catalytic converters at an appreciable increase in first cost and maintenance. A favorable result is that by retuning the spark advance and air-fuel ratio and better programming of EGR, some improvements in gas mileage will be realized. However, no-lead gas, which is more expensive to produce, will be essential. So far, and at least to 1976, it is possible to meet the laws by modifications or add-ons to the conventional carbureted, spark-ignition engines. Meanwhile, more drastic modifications and other types of engines have been investigated.

The resources in manufacturing facilities for the present engines are enormous. The facilities needed for a drastic change in type of engine would be equally enormous. Therefore, the industry looks most favorably to, and is trying hardest to qualify, those engines allowing maximum use of the present resources.

There is another factor favoring minimum change. The machine tool industry has a very limited capacity in the building of transfer lines. The more drastic the changes, the more time needed to convert the total industry. A complete retooling of the automobile engine production lines would take about 10 years. Although the maximum rate might be higher, it is doubtful that the average output of a single engine transfer line is over 300,000 per year. Some may be much lower due to limited demand for certain engines. At 300,000 engines per year per line, a total requirement of 12,000,000 engines per year (exclusive of trucks) and estimating that the machine tool industry can produce four new automobile engine transfer lines per year, it would take 10 years for the 40 lines.

A third consideration has to be research, engineering, testing, and development. A simple modification such as an EGR system may be engineered and developed for production release in, perhaps, a year. A completely new engine concept has to be analyzed for results to be expected, for adaptability to present vehicles, for new techniques that might have to be developed, for costs, for customer acceptance, and finally for profitability. If the study looks favorable, prototypes will be designed, built, and tested. The more drastic the change, the longer and more thorough will be the testing. Tooling may be planned but will not be ordered until there is considerable confidence in the design.

Perhaps the most significant engine modification retaining most of the tooling for present engines would be the conversion to electronic fuel injection (EFI). New high-production facilities would have to be provided for the fuel injectors and faster manufacturing techniques developed. The electronic controls are still under development to simplify them and to reduce their cost but techniques are known and facilities could be provided. New inlet manifolds would be needed. Carburetors would no longer be used. The trade-off costs of the EFI system would be somewhat higher than the carburetor. The claimed advantages are closer control of air/fuel ratio (possibly eliminating the need for oxidizing catalysts) and better control of fuel distribution between cylinders (allowing leaner mixtures to be used and improving fuel economy). If NO_x is limited to 1.5 g/mi or below, either dual-catalyst of a three-way catalyst system will be needed. It may not be possible to justify the added cost of EFI unless catalysts can be eliminated. It will probably appear in one or more cars in 1975 by the expedient of importing parts. The system is well-developed but needs further testing to improve confidence. If this system proves effective, it will need no major changes in basic engine tooling but will need additional tooling for the fuel system. Conversion of a substantial part of the industry to EFI would take at least two years for further development and high production tooling. This will delay quantity production until perhaps 1977.

Next in order of necessary changes to tooling is the divided chamber, carbureted, stratified-charge engine as exemplified by the Honda CVCC. Only the cylinder heads and manifolds would need new transfer lines. Carburetor lines would have to be changed to some extent. No extensive changes would be needed in the rest of the engine. With this system, it is possible to hold NO_x below 2.0 g/mi with little sacrifice in fuel economy and without the use of catalytic converters. A reactor type exhaust manifold is needed, however. Before this system comes into general use, there will be a lot more testing of driving characteristics and maintenance factors to guard against high warranty costs and customer dissatisfaction. Although there may be an introduction of this system as early as 1976 in a few models, it should not be expected to appear in substantial production before late 1977. Because of the limitations of engineering, test facilities, and procurement of tooling, additional models in any one company will probably be spaced at two year intervals.

A modification of this CVCC concept uses fuel injection into the pre-chamber rather than carburetion. There may be engineering advantages to this system since it does not need an extra inlet valve. It does need a timed, high-pressure fuel system, however. The main-chamber fuel supply may be either injected or carbureted. Development of this system has not progressed to the point where an accurate assessment of advantages can be made. It will need a new cylinder head (to accommodate the pre-chamber), a new fuel-injection system (possibly dual injection), a new exhaust manifold (for thermal reaction), and perhaps a new inlet manifold. In any case, it would not appear before 1978 at the earliest.

The true stratified-charge engine is exemplified by the Texaco TCCS and the Ford PROCO engines. These engines, by directing the inlet air, cause orderly swirl in the main combustion chamber. Fuel is injected into this swirl and is carried over to the spark plug where ignition takes place. Ideally, throttling of the inlet air is not necessary, an ignitable mixture should exist at the spark plug regardless of the excess air. In practice, some throttling may be used to reduce the HC at light loads (because the mixture is not ideally stratified) and to keep the exhaust temperature up for the catalytic converter which seems to be necessary. Texaco has achieved some excellent results in prototype engines but has never manufactured engines for commercial sale. Engine manufacturers have shown considerable lack of enthusiasm for this type of engine. Production would require new cylinder head lines, new manifold lines, changes or additions to the cylinder block lines, and, above all, a timed, high pressure fuel system identical in principle to that used in a diesel engine. It is most probable that the relationship between fuel system and ignition system over the spectrum of speed and load invites maintenance problems. The main advantage seems to be insensitivity to octane ratings of fuels. It is doubtful that emissions are noticeably better than in the divided chamber engines and the power output will be seriously reduced because of the stratified charge. This engine has been undergoing vigorous development for 20 years and is not in commercial production anywhere in the world. This does not instill confidence in its release for production in the near future. It must be expected that development and testing will be continued until the reliability and reproducibility of the system are assured. The manufacture of the fuel system in large quantities calls for new high production techniques and extensive tooling. A breakthrough might change the picture but it is not likely to appear before 1979.

Only slightly more involved than the PROCO or TCCS in tooling complexity is the light automotive diesel. It requires a completely new cylinder head, new inlet manifold, and many modifications to the cylinder block. A timed, high pressure fuel pump and individual fuel nozzles are needed. Some increase in structural strength is also needed in pistons, connecting rods, and crankshaft. Some increase in weight is inevitable, but the light-duty automotive diesel should not be confused with the heavy-duty diesels now almost universally used in large trucks and heavy machinery and becoming increasingly popular in medium-duty trucks up to 45,000 lb GVW. The life of a light-duty automotive diesel need be no greater than that of a good automotive, spark-ignition engine. Consequently, the weight will not be prohibitively different. Unlike the PROCO or the TCCS engines, the diesel has proven itself over the years -- all the way down to medium-size cars -- as a thoroughly reliable, economical engine. The quickest way to get into production with this type of engine would be to import existing engines from Europe or Japan. Since little tooling would be needed, this could occur as early as 1976. Three American automobile manufacturers have such sources available. There are two disadvantages to this. One, there probably is very little excess capacity in any of these foreign plants. Two, these are small engines, suitable only for compact and mini-compact cars. These proven engines could be tooled up in the U.S. with minimum delay for development. The fact that they are small is unfortunate since there is a real need for a larger engine, say 350 CID, to power pick-ups, other light trucks and the larger-size family cars. The most optimistic schedule might be: small diesel imports in 1976; the same engines tooled in the U.S., 1977; and new larger engines engineered, developed, and tooled by 1979. Again it should be emphasized that this is for the first engine model. Because of the extensive tooling changes, other models would have to be scheduled at perhaps two year intervals.

The primary advantage of diesel engines would be a very substantial reduction in fuel consumption. A secondary characteristic is the normally low HC, CO and NO_x emissions for the divided chamber diesel without the need for fine tuning, without reduction in efficiency, and without catalysts. As a matter of fact, the cool exhaust and large quantities of excess air makes oxidizing catalysts ineffective and current reducing catalysts for NO_x control unusable. A reduction in permissable NO_x to lower than 2 g/mi would rule out this efficient, reliable engine.

Another engine which seemed so promising a few years ago is the Wankel. It has many attractive features. It has no reciprocating parts. It works on the 4-stroke cycle with each stroke lasting 270° and with one power stroke per revolution. At any time, three of its four strokes are acting. Each rotor is therefore effectively equivalent in the smoothness to a three cylinder, 4-cycle engine. Its displacement is the rotor area (corner-to-corner length x width) x 3 times the crank radius for every revolution of the crank. This produces large swept volume in a small space and promises high performance. Total balance is accomplished easily by means of counterweights on the crankshaft. Unit inertia forces are low (very short stroke and large bearing allowing high speeds with low bearing loads). It is easy to see how attractive this becomes to someone looking for a high performance vehicle. Its minimal size and low weight allow new economical vehicle designs.

Nevertheless, there are drawbacks. The piston face is rectangular in cross section, rather than circular, causing leakage problems at the corners. The apex seal travel is one third the periphery of the trochoid surface per revolution in the same area of the trochoid which induces high local temperatures. There is no way to return lubricating oil to the pump so the amount of lubrication at the apex seals is limited to the quantity of oil wasted. All this leads to very critical seal wear problems. The combustion chamber extends from corner to corner of the rotor. Variously shaped pockets in the rotor have been tried in an effort to improve the combustion chamber shape and some progress will be made. Nevertheless, combustion is relatively slow with a strong tendency to quench out on the large surfaces. Poor fuel consumption and high emission of HC and CO are to be expected. At the same time, the low combustion temperature and the recirculation of exhaust gas during the unavoidable overlap keeps the NO_x at a low level. If efforts to improve the efficiency are successful, unquestionably the NO_x output will increase. Thermal reactors or catalysts will be needed to oxidize the HC and CO. If the NO_x limit should be reduced to much below 2.0 g/mi, an effective reduction catalyst will be needed.

Production tooling for building this engine is on order. It should be expected that some small cars will be equipped with these rotary engines in 1976, but because of the high fuel consumption and indeterminate endurance, it is doubtful that there will be large volumes produced in the foreseeable future.

A composite summary of development, tooling and production lead imes based on the discussion above is presented in Table 7-1.

It should be realized that responsible management will not willingly take the long-term risks needed to engineer, develop and produce any new type of engine without assurances that the emissions laws will remain stable long enough to allow recovery of the investment before the product becomes obsolete.

Electronic Fuel-Injection Systems*

The electronic fuel-injection systems for gasoline piston engines are primarily a development of European technology although the Bendix Corporation in the U.S. has a cross-licensing arrangement with Bosch in Germany for technology exchange. No mass production manufacturing facility exists in the U.S. to produce electronic fuel-injection and electronic emission-control subsystems for gasoline piston engines.

The EFI system that is being introduced in Europe for U.S. sales is illustrated in Figure E1. The prime components of this system are:

Fuel pump (39PSIG) - an electrically driven motor coupled to a constant flow rotary pump.

Fuel filter - a close tolerance filter that eliminates particles that would clog the fuel nozzles.

Fuel intake manifold - with provision for mounting the fuel rail.

Fuel nozzles - a precision solenoid operated by the electronic control unit.

Throttle body - the basic air control unit that includes a bottle sensor and a cold start air control.

Speed sensor unit - the magnet assembly equipped with a reed switch assembly for sensing the engine RPM.

Electronic control unit - this system provides the control signals and the feedback response from water and air sensors, pressure sensors and a fuel pressure regulator.

---

[*] Contributed by LeRoy Lindgren.

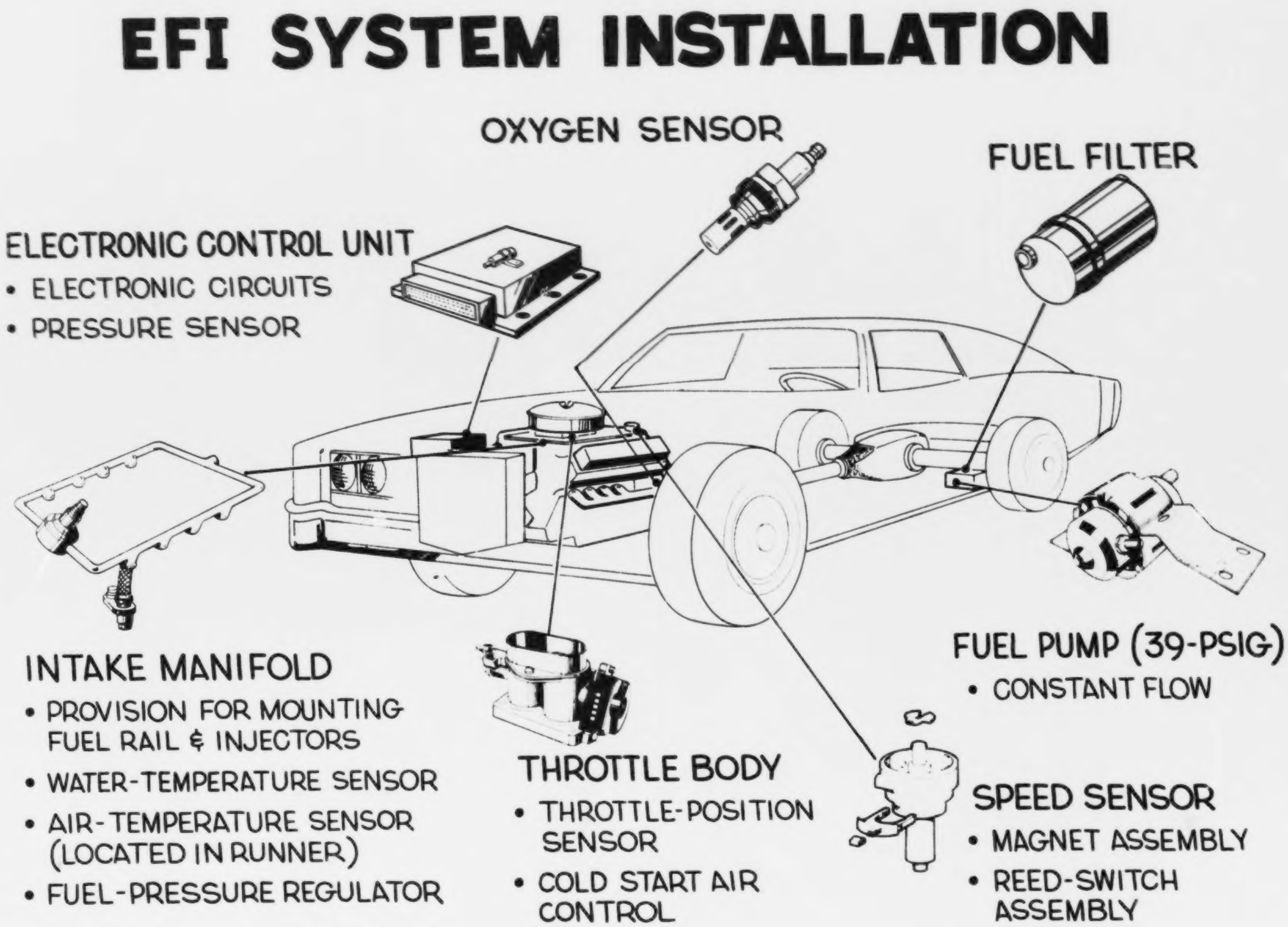

EFI SYSTEM INSTALLATION
OXYGEN SENSOR
FUEL FILTER
ELECTRONIC CONTROL UNIT
• ELECTRONIC CIRCUITS
• PRESSURE SENSOR
INTAKE MANIFOLD
• PROVISION FOR MOUNTING FUEL RAIL & INJECTORS
• WATER-TEMPERATURE SENSOR
• AIR-TEMPERATURE SENSOR (LOCATED IN RUNNER)
• FUEL-PRESSURE REGULATOR
THROTTLE BODY
• THROTTLE-POSITION SENSOR
• COLD START AIR CONTROL
FUEL PUMP (39-PSIG)
• CONSTANT FLOW
SPEED SENSOR
• MAGNET ASSEMBLY
• REED-SWITCH ASSEMBLY

FIGURE E1 Typical EFI System

Oxygen sensor - the platinum-coated ceramic sensor located in the exhaust stream.

This EFI system coupled with a three-way pellet catalyst converter is being tested in Europe and U.S. Some European automobile companies are planning to use this system for tighter standards.

The Panel of Consultants on Manufacturability and Costs has assembled the estimated costs of the components of this system using data supplied from U.S. companies and some European suppliers. These costs are original equipment manufacturer (OEM) estimates with appropriate volumes of production; that is, they are costs for the component on a car made in mass production. Table E1 illustrates the detailed costs for EFI components and for components needed for several alternative engine technologies.

The data supplied to the Panel of Consultants on M/C indicated that the electronic control unit would not reduce in cost as the production increased. This was based on the assumption that this unit would be designed to incorporate ceramic encapsulated, integrated circuit technology and that the cost would remain constant. It is the opinion of the Panel of Consultants on M/C that some cost reduction would be achieved. Therefore, a 12% cost reduction due to learning has been applied to the manufacturing costs listed in Table E1 for EFI technology when using manufacturers low-volume cost data.

Introducing a new engine technology such as EFI is a more gradual and evolutionary process than might be inferred from Table 7-1. For production of electronic fuel-injection systems, the following schedule is typical once a decision has been made to introduce EFI in a significant number of cars:

TABLE E1

Typical Component Sticker Price
Used in Developing Vehicle Costs

Component	Sticker Price, in Dollars*		
	4 Cyl.	6 Cyl.	8 Cyl.
Air Injection-Pump-Valves-Piping	27	31	33
Fuel-Evaporation Control	8	10	11
Distributor Assembly	7	14	21
PCV Valve	2	2	3
Improved EGR	11	12	14
Most Advanced EGR	18	20	22
Oxidation-Catalyst Pellet Converter	--	--	76
Oxidation-Catalyst Monolith Converter	47	58	--
Reducing-Catalyst Pellet Converter	--	--	82
Reducing-Catalyst Monolith Converter	63	74	--
Oxygen Sensor	4	4	4
Three-way-Catalyst Pellet Converter	80	92	92
Fuel-Injection Nozzles	25	42	57
Electronic-Emissions Control Unit	50	56	57

* Investment allocation is not included. Blanks in table indicate that costs were not needed for the computer analysis and, therefore, were not developed for this study.

Year	Volume	Production Plan
1975	5,000	Purchase all the components from known U.S. and European sources.
1976/77	200,000	Start manufacturing nozzles, throttle bodies, fuel pumps and ECU units Purchase the valves and sensors. Purchase mass production tooling.
1978/79	500,000	Redesign the ECU using integrated circuits and combine some external functions into the ECU. Provide for mass production facilities of the major components. Include the major valves as manufactured items.
1979/80	1,000,000 to 5,000,000	Develop a new cost reduction design and include the balance of the items in the manufacturing program. Tool up the final mass production facilities for all components.

The total investment for such a facility to produce 5,000,000 units per year would be $55,000,000 which include launching costs and equipment costs. Over $11,200,000 would be expended for tooling nozzl alone.

The Stratified-Charge Engine

As discussed earlier, a quick, but not necessarily, a final, ar to the energy and emission problem appears to be minor modification of existing production engines. The next step, in order of ease of alteration, appears to be some form of the stratified-charge engine. There a so many permutations of the so-called stratified-charge engines that the most promising compromises may not yet have been sorted out. All versions are capable of low NO_x and CO. Hydrocarbons can be high for unthrottled engines to fairly low for throttled versions. Fuel consumption can be normal for divided chamber engines or low for high compression, unthrottled, swirl chamber engines. Fuel systems can be relatively simple carburet or highly sophisticated injection systems. Power loss can be minimize (with some loss in emission control) or emissions can be minimized with some loss in power. The best compromises will be based on experience and judgment and, of course, the legal requirements which must be met.

The costs of getting into production with any of these systems would be the tooling costs for the new cylinder heads, say $4,000,000/ per engine line plus the building and services. The swirl-controlled stratified-charge engine would also need high volume tooling for the injection systems, $15,000,000 per transfer line. Many millions of dollars have been spent on developing the first production engine. If the results are favorable, additional engine models can be developed at lesser costs.

Since additional tooling may be required only for the cylinder head and fuel system, plus minor block changes, the time frame may be dictated by the amount of testing and development necessary to assure a commercially acceptable engine. At least a two year delay period is indicated for limited production, with perhaps a four year delay for large volume production. This time frame may be compared to that required for diesel engines.

Light Automotive Diesels

One of the alternative engines promising a measure of relief to the critical fuel supply, and at the same time offering a large reduction in the naturally emitted exhaust pollutants, is the light-duty automotive diesel. This is not a new concept nor is it a new unproven engine. Almost all heavy trucks are now diesel powered. Many medium-sized trucks are beginning to use diesel power. In Europe, many light trucks, taxicabs and passenger cars are now diesel powered. But in spite of their general acceptance in Europe, diesel engines are usually regarded as unsatisfactory for American passenger cars because of poor performance, excessive weight and high cost. On the other side are the inherent advantages of low fuel consumption and low emissions of unburned hydrocarbons, carbon monoxide, and oxides of nitrogen without fine tuning or complicated add-ons.

While the Panel of Consultants on M/C is primarily interested in costs, it is essential to have a background on which to base these costs. For instance, engine performance requirements determine engine size which determines weight, both of which affect cost. Much of the objection to diesel engine performance is based on the Mercedes MB 220D in which a 134 CID diesel developing 55 horsepower net is installed in a vehicle weighing 3,100 lb. In Europe, cars are small, engines are smaller, and spark-ignition engines are tuned up to a very high specific output. This performance can not be matched with a diesel engine. In the U.S., a different policy is followed. Engines of more modest specific output but larger displacement provide a high degree of vehicle performance. The relationship between displacement and car weight for 1973 cars is plotted in Figure E2. Also shown in the MB 220D which is well below the U.S. average. If the diesel were of larger CID, vehicle performance would certainly improve. But if we increase the size of the diesel to exactly equal the performance of the spark-ignition engine, we will exaggerate the other disadvantages of the diesel, weight and cost, which could become prohibitive.

A more practical approach would be to match displacement of the spark-ignition engine rather than the power. There will be some loss of power but we can evaluate this loss by using as a performance parameter, horsepower per unit piston area corrected for bore/stroke ratio, a valid and dimensionally rational parameter.

The published performance of standard equipment engines for 1973 model cars showed an average output of 1.71 Hp/Ac with a one sigma spread from 1.47 to 1.94 as shown in Figure E3. The dashed lines enclose the one sigma limits for 68% of the engine population. The scatter is of little significance since all of these engines can be stepped-up in power and most of them are offered in higher power options. This figure shows that three European diesels have a specific performance inside the scatter band of the standard equipment spark-ignition engines. Since all of the

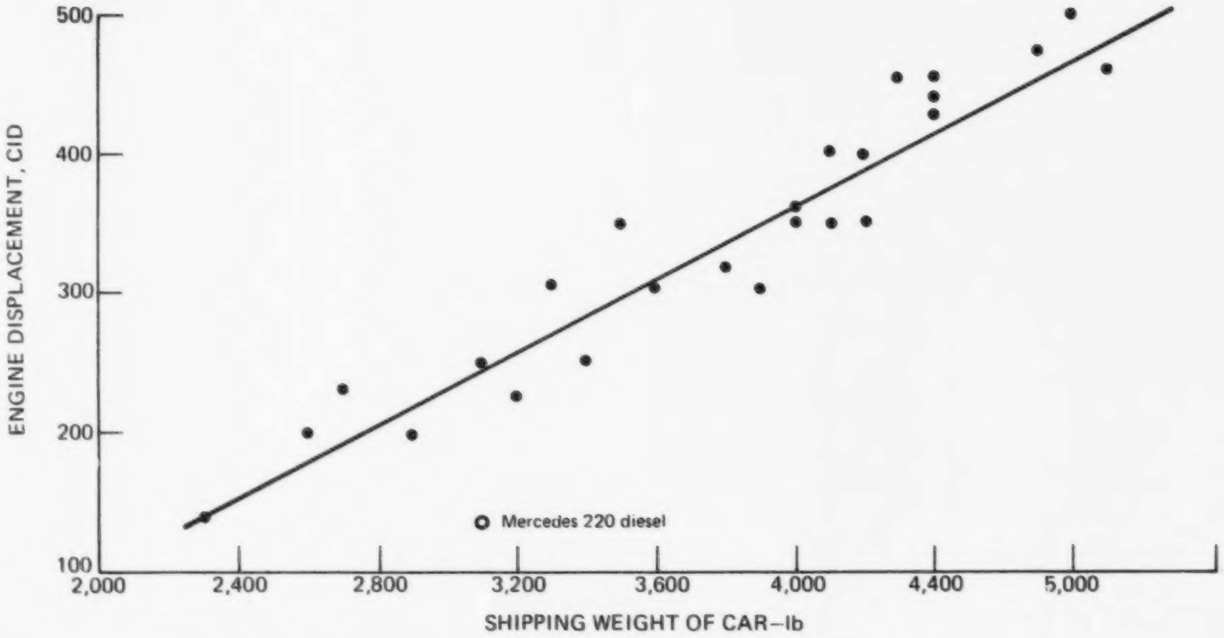


FIGURE E2 Engine Displacement (CID) as a Function of Car Weight for 1973 Model Year, U.S. Produced Cars (●). Mercedes 220 Diesel Is Included for Comparison.

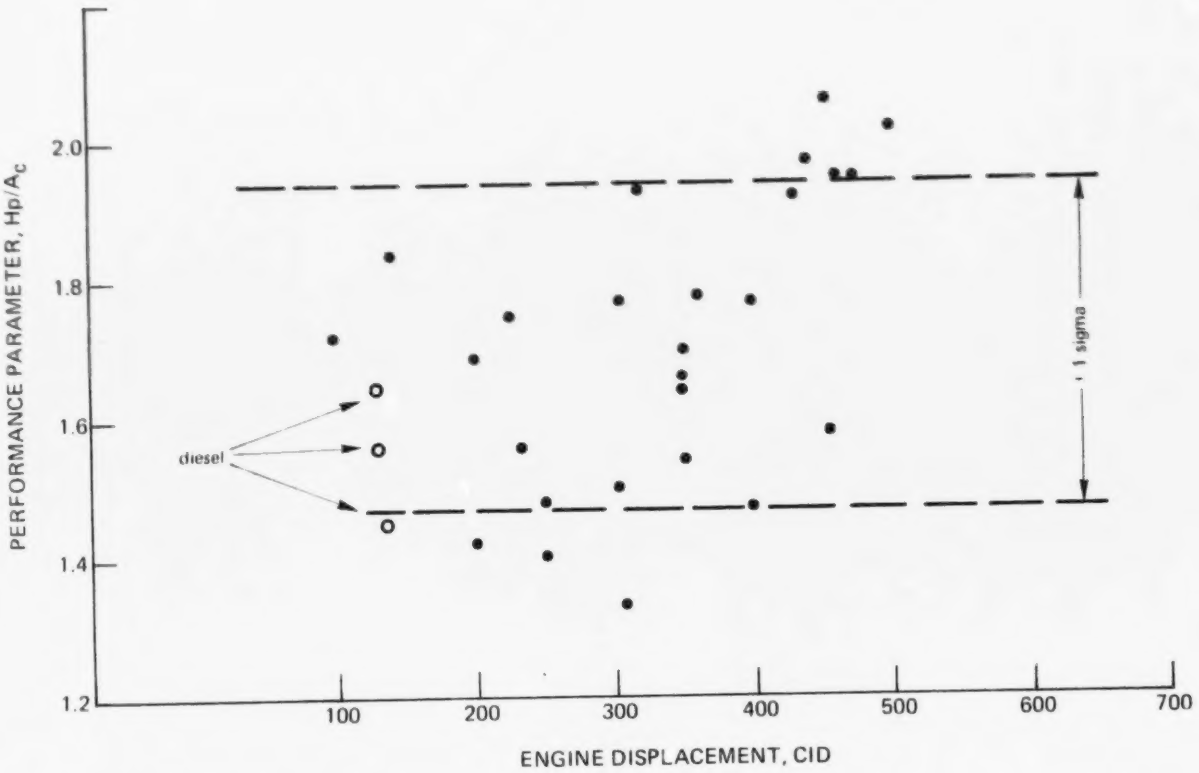


FIGURE E3 Comparative Performance of U.S. Produced, 1973 Gasoline Engines (●) and Three Imported Gasoline Engines. High Performance Engines Are Excluded.

U.S. engines are sold in high sales volume cars, we can assume that their performance was acceptable to a large segment of the market. We can also conclude that the diesel engines can deliver comparable specific performance if they are equal in displacement to spark-ignition engines.

If we accept a diesel of the same displacement as the spark-ignition engine, we have a basis on which to compare other values, weight for instance. A diesel engine of the same displacement will be heavier than a spark-ignition engine. Exactly how much heavier is impossible to say unless we compare similar designs. The crankshaft, connecting rods, and pistons may be 50% heavier. Heavier flywheels may be necessary in 4- and 6-cylinder engines. The cylinder heads may weigh 20% more. There will be more metal in critical areas of the cylinder block. However, a diesel, built to the same standards of reliability as the spark-ignition engine, would be less than 25% heavier. Considering the many engine options that are offered in today's cars, a weight increase of 25% should not be prohibitive. At most, there would be a net increase in weight of 10% on the front suspension over the largest fully optioned gasoline engine which will fit in the car. All of the special considerations regarding the conversion are summarized below:

1. All diesel engines need fuel pumps with timed injection requiring a half speed, positive drive from the crankshaft.

2. Crankshaft bearings are larger in diameter for strength to provide adequate bearing area and for torsional stiffness because of higher peak pressure.

3. Crankshafts may have to be heat treated for strength, especially if turbocharged. Turfriding, Elo-therm fillet hardening, deep harding to at least Rc 30, or fillet rolling should be considered.

4. Pistons will be designed for high compression loads; wrist pins will be large in diameter. A ring groove insert may be needed for good life. A closely controlled combustion chamber will be machined into the piston top.

5. Cylinder heads will need at least five evenly spaced hold down bolts because of high gas pressure.

6. If lowest emissions are to be achieved, a divided-combustion chamber will be needed with an inserted pre-combustion or swirl chamber in the head. Dimensional control must be precise.

7. There will be no vacuum available for operation of brakes or auxiliaries.

8. The performance and efficiency of a diesel engine depend on the shape of the combustion chamber and tailoring the fuel system to fit. This involves a great deal of experimentation and development. Therefore, it is not a simple thing to change a bore or stroke.

9. Diesel engines have high cyclic torque variations, even at idle, because of high compression pressure. Engine mountings must absorb these torques.

10. Diesel engines prefer long stroke/bore ratios because of the more compact combustion chamber. In-line engines are more compact, lighter, and probably cheaper to build with short strokes, even though there may be some sacrifice in performance and efficiency. Therefore, it is economical to build 4- and 6-cylinder engines of the same configuration as a family,but it is not good policy to build a V-8 of the same bore and stroke as an in-line.

The cost of manufacturing engines in quantities of at least 200,000 per year is approximately proportional to weight. Tooling costs for a diesel may be somewhat greater than for a spark-ignition engine because of the greater mass of the components. An increase in tooling cost of perhaps 10% can be expected.

Although the tooling of the diesel and spark-ignition engines will be similar, it will not be feasible to phase out the spark-ignition engine and phase in the diesel on the same tooling for several reasons. First, so many dimensions are so different it is unlikely that any large part of the old tooling could be adapted. Second, no manufacturer can afford to take out of production a popular engine for the period of a year or more necessary for a changeover. Third, even if an engine is taken out of production, service and maintenance commitments dictate that a considerable part of the tooling will be in use for several years. New tooling is therefore mandatory.

At today's prices, transfer line tooling for 200,000 engines/year will cost approximately $80,000,000, not including the building. Design, development, and testing of prototypes will add another $20,000,000. A building to house the operation could cost $6,000,000, bringing the total to $106,000,000. This is a conservative estimate of the investment cost for only one engine line. Obviously, these costs will have to be amortized over a large number of engines.

Conversion of Manufacturing Facilities

The Panel of Consultants on M/C considered at length the conversion impact of changing transfer lines from the conventional 1974 engine to the following:

a. Conventional engine with a dual-catalyst emissions system.

b. Diesel engine using the Mercedes-Benz technique of maximizing the compatibility between gasoline diesel engine production.

c. Diesel engine using an all-new light-duty automotive design.

d. Piston engine with electronically controlled fuel-injection and emission system.

e. Stratified-charge, 3-valve design (Honda CVCC).

f. Stratified-charge (TCCS/PROCO) with mechanical fuel injection.

g. Wankel engine.

The result of this composite Panel of Consultants judgment is presented in Table E2 for engines a through f and in Table E3 for the Wankel engine (g). From Table E2, it can be seen that the progressive order of increasing impact is dual-catalyst, EFI, CVCC, TCCS, diesel and Wankel. This is the same ordering presented earlier in this Appendix. When conversion is viewed from the perspective of these impact tables, the industry tendency for favoring technologies, such as dual-catalyst systems, which minimize the disruption becomes more rational.

TABLE E2

Impact of Conversion of a Conventional 1974 Engine Complex to Various Alternative Engine Systems

	Impact					
Transfer Line	Dual Catalyst D/C	Diesel Conv.**	Diesel New	Elect. Fuel Inject.	Strat. Charge 3-Valve CVCC S/C	TCCS Texaco MFI
Block	N	1,500 M	L	N	N	1,500 M
Head	N	L	L	500 M	L	L
Intake Manifold	N	250 M	L	L	L	L
Exhaust Manifold	300* MA	200 M	L	N	L	L
Front Cover	N	L	L	N	N	L
Oil Pan	N	N	L	N	N	N
Valve Cover	N	L	L	N	L	L
Clutch Hsg	N	N	L	N	N	N
Flywheel	N	200 M	200 M	N	N	N
Camshaft	N	M	N	N	100 M	N
Crankshaft	N	300 MA	L	N	N	N
Pistons	N	20 M	L	N	N	200 M
Piston Pins	N	N	N	N	N	N
Connecting Rods	N	150 M	150 M	N	N	N
Valves	N	50	50	N	100	50 M
Rocker Arms	N	20 M	20 M	N	100 MA	20 M
Distributor	N	NR	NR	200 M	N	300 MA dual
Oil Pump	N	N	N	N	N	N
Booster Fuel Pump	N	L	L	L	N	L
Fuel Inj. Pump	NR	L	L	L	NR	L
Inj. Nozzle	NR	L	L	L	NR	L
Governor	NR	L	L	NR	NR	L
Fuel Filter	N	500 MA	500 MA	300 M	N	500 MA
Air Filter	N	300 M	300 M	300 M	N	300 M
Carburetor Assembly	M	NR	NR	NR	MA	NR
Carburetor Body	M	NR	NR	NR	MA	NR
Throttle Body	NR	NR	NR	L	NR	L
PCV Valve	N	150 M	150 M	N	N	N
Fuel Evap. System	N	NR	NR	N	N	N
Converter Can	L	NR	NR	MA	NR	L
Catalyst Substrate	L	NR	NR	MA	NR	L
Engine Assembly	M	200 MA	200 MA	500 MA	300 M	700 MA
Foundry Changes	300 M	1,500 MA	1,500 MA	800 MA	900 M	2,000 MA

* Numbers are associated investment costs in thousands of dollars.

** Impact for a dieselized gasoline engine, rather than a totally new diesel engine design.

KEY:

N - No change in the original transfer line.
M - Minor changes in the original transfer line.
MA - Major change required in the original transfer line.
NR - Original transfer line not required for the new engine system.
L - New transfer line is required.

TABLE E3

Impact of Conversion of a Conventional
1974 Engine Complex to a Wankel Engine

(Note the relative high degree of incompatibility between the two engine systems.)

Transfer Line	Impact
Engine Assembly	L
Engine Test	L
Transmission	MA/or L 500*
Drive	L
Air Pump	500 M
Thermal Reactor	L
Catalyst Converter	L
PCV	N
Fuel Evap. System	N
Carburetor IFC	L
Front Hsg	L
Trochoid Rotor Hsg	L
Rotor	L
Side Seals	L
Rear Hsg	L
Crankshaft	L
Distributor	200 M
Oil Pan	100 M
Flywheel Hsg	L
Flywheel	L
Oil Pump	L
Fuel Pump	300 M

Transfer Line	Impact
Fuel Filter	Transfer N
Air Cleaner	N
Carburetor IFC	L
Apex Seals	L
Car Assembly	3,000 M
Foundry	L
Fuel Storage Plt	300 M
Exhaust/Muffler Plt	300 M
Power Options	N
Coolant System	N
Brake System	N
Drive System	L
Wheels	N
Tires	N
Air Conditioning	N
Accessory Equipment	N
Electrical System	N
Body	2,000 N/MA
Ignition System	300 M
Suspension System	N
Power Options	N

* Numbers are associated investment costs in thousands of dollars
Key: N = No change; M = Minor change; MA = Major change; L = New transfer line required;
NR = Old transfer line not required.

APPENDIX F

Assumptions for Scenarios and Detailed Time-Phased Plans

(Compiled by Merrill L. Ebner and
LeRoy H. Lindgren)

As used in this study, a scenario is defined to mean a time-phased pattern of cars selected from the list of available configurations in Table 3-2.* The pattern in some cases is that which the domestic automobile industry might make given a certain pattern of emissions standards (the E Scenario is such a case). Other more hypothetical scenarios (such as Scenario ED-2) ask what time-phased pattern might result if the industry decided to introduce a significant amount of a new technology such as automotive diesel.

In the present study, 19 different scenarios are created and evaluated. These are listed in Table F1. The corresponding pattern of emissions standards are given in Table 4-6. In all cases, the first letter in the scenario designation indicates the applicable pattern of standards which applies in that scenario.

Scenarios can be divided into five groups according to the general purpose that they serve. One group (A,B,C,E,E-2,I,J and K) represents emissions patterns as they have existed, as they now exist, or as they might exist (K). A second group is created to study the two-standard strategy (B^1J^1 and C^1J^1). A third group is used to evaluate the effect of a more radical small-car shift (CSV, JSV and KSV). A fourth group (ED, ED-2, ESC, ESC-2 and EW) assumes a special emphasis on new technologies, and the fifth and final group (containing only F1) assumes both a mixture of new technologies and a hypothetical final standard (1.0 g/mi for NO_x).

---

*A scenario, if it were implemented, would be called a production plan.

TABLE F1

List of Scenarios for This Study

Scenario	Final Emissions Standard	Comment
A	US70	Baseline scenario
B	US73	Standards as applied through 1973
B'J'	US73 & US78	Two-car strategy; 63% B pattern, 37% J pattern
C	US75	Standards
C'J'	US75 & US78	Two-car strategy; 63% C pattern, 37% J pattern
CSV	US75	Same as C, but using a small-car product mix
E	I77	Advanced oxidizing catalyst and EFI systems to a 2.0 g/mi NO_x standard
E-2	I77	Advanced oxidizing catalyst system to a 2.0 g/mi NO_x standard
ED	I77	Diesel and EFI
ED-2	I77	Diesel introduction
ESC	I77	CVCC and CCS introduction to a 2.0 g/mi NO_x standard
ESC-2	I77	CVCC introduction to a 2.0 g/mi NO_x standard
EW	I77	Wankel introduction at a 2.0 g/mi NO_x standard
F1	T277	Several alternative technologies to a 1.0 g/mi NO_x standard
I	US78	Standards as in original Clean Air Act Amendments of 1970
J	US78	Standards as in Emergency Energy Act of 1974
JSV	US78	Same as J, but using small-car product mix
K	US78	Same as J, but with 0.4 g/mi NO_x deferred to 1980
KSV	US78	Same as K, but using small-car product mix

Because it is the input, or driving function, for the evaluation of impacts on both the driving public and the industry, the quality of the scenario is of considerable importance. Consequently, scenarios reflect the learnings from the Panel of Consultants on M/C questionnaire (Appendix B), the data gathered by the Panel of Consultants, the information on tooling constraints (Appendix D), and lead-time considerations (Appendix E) as accurately as was possible under the conditions of the study. That is to say that new vehicles are brought into the scenario in ways which are possible in a development and production sense. How relatively cost effective the scenario is will then be determined by subsequent investment and operating cost analysis.

The function of the scenario is to describe the new cars added to the U.S. vehicles-in-use population. The basic scenario (as they will be presented in this appendix) indicates the yearly additions from U.S. and Canadian plants to the U.S. market. This basic scenario is the one used in the investment analysis, since the investment impact on U.S. producers was sought. The contribution of imported cars is then added to this basic scenario to create the extended scenario used for the vehicle operating cost calculations (Appendix G). Imported cars are those imported by U.S. manufacturers and those exported to the U.S. by overseas manufacturers.

The total yearly car sales is the same in all scenarios and is assumed to be as shown in Table 4.1. This table contains historical data for 1970 through 1973. An 11% drop in total sales for 1974 over 1973 is assumed, as in a 3.5% yearly increase, subsequently. The ratio of import sales to total sales is assumed to be 15% from 1974 to 1985.

Initially, there was some question as to whether production or sales data is preferable as a basis in the scenarios. Consequently, the comparative sales and production data for the U.S. in the period 1970 to 1973 was tabulated as shown in Table F2. In some years, as can be seen, (1970 and 1972) sales run ahead of production and in other

TABLE F2

Comparison of Car Shipments, Sales, and Registrations for 1970-1973

	Calendar Year			
	1970	1971	1972	1973
Domestic				
Total Shipments[1]	6,869	8,901	9,189	9,941
Total Dealer Sales	7,116	8,676	9,322	9,670
Imports				
Total Import Sales[2]	n/o[3]	1,533	1,586	1,733
Total U.S.				
Total Sales	n/o	10,209	10,908	11,403
Total New Car Registrations	8,388	9,831	10,488	11,351

Source: Ward's Yearbook 1973 and Ward's Yearbook 1974.

---

[1] Domestic factory shipments including exports plus imports from Canada minus exports by domestic producers.

[2] Imports by domestic producers plus exports to the U.S. by all non-Canadian overseas producers.

[3] n/o = not obtained

years (1971 and 1973), the reverse is true. The differences represent fluctuations in new-car inventories. In all cases, sales and production are reasonably close. Consequently, sales data are used and sales and production are considered to be equal to a first approximation.

Another feature included in the scenarios to bring them into correspondence with industry practice is the distinction between the model year and the calendar year. The model year production traditionally begins about September 22. As a compromise here, the start of the model year is assumed to be September 1. Data for automobile sales for the first three quarters and the last quarter of the years 1970-1973 are given in Table F3. On the average, as can be seen, 25% of the yearly production is in the final quarter. Consequently, on the worksheets on which the scenarios are built, the total production is divided 75%/25%. The 75% volume is assigned to the prior model year and the 25% to the next model year. Thus, a small volume of production of a diesel car appearing for the first time in 1977 is, in fact, the fourth quarter's sales of a 1978 model year vehicle.

Once a yearly volume is established, it is divided among the seven car sizes according to the normal pattern (Table 4-2) or the small-car pattern (Table 4-4). The data from these two figures are consolidated and presented here again as Table F4. In this table, the relatively greater severity of the small-car shift in the small-car pattern is apparent. The Intermediate B and standard cars are the main losers in this shift. In Table F4, the percentages for the years 1970 to 1974 are the same for both product-mix patterns. The percentages for 1970 to 1973 are historical based on Ward's data, and the 1974 data are an estimate for that year. All scenarios used the normal product-mix pattern, except for those designated "SV" which used the small-car pattern.

For the model years 1970 to 1974, all U.S. auto companies met the progressive emissions standards with very similar hardware. In

TABLE F3

New Car Sales by Franchised Dealers

Calendar Year	Jan. - Sept.	Oct. - Dec.	Total
1970			
Sales Volume	5,625,884	1,489,653	7,115,537
%	79.1	20.9	100.0
1971			
Sales Volume	6,246,476	2,429,808	8,676,284
%	72.0	28.0	100.0
1972			
Sales Volume	6,780,232	2,541,271	9,321,503
%	72.7	27.3	100.0
1973			
Sales Volume	7,461,434	2,208,255	9,669,689
%	77.2	22.8	100.0
NAS Scenarios			
4-Year Aug.	75.2	24.8	
Value Used	75	25	

Source: Ward's Yearbook 1973, p. 134; Ward's Yearbook 1974, p. 140.

TABLE F4

Comparison of the Product-Mix Matrix for the Normal and Small-Car Patterns

(Numbers are the percentage of a given year's sales in that car size.)

Projected Car Sales by Car Size

		70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
MINI	S/V	0	0	0	0	0	1	3	5	6	7	8	8	8	8	8	8
	N	0	0	0	0	0	1	2	3	3	3	3	3	3	3	3	3
S/C	S/V	0	7	9	8	9	11	13	15	17	19	21	22	22	22	22	22
	N	0	7	9	8	9	10	11	12	13	14	14	14	14	14	14	14
COMP	S/V	13	12	11	10	11	13	15	17	19	21	23	24	24	24	24	24
	N	13	12	11	10	11	12	13	14	15	16	17	17	17	17	17	17
INT-A	S/V	19	18	18	18	18	19	20	21	22	23	24	24	24	24	24	24
	N	19	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
INT-B	S/V	32	30	29	30	29	26	23	20	18	15	12	11	11	11	11	11
	N	32	30	29	30	29	28	27	25	25	24	24	24	24	24	24	24
STD	S/V	21	19	19	21	20	17	14	11	8	6	4	3	3	3	3	3
	N	21	19	19	21	20	18	16	15	14	13	12	12	12	12	12	12
LUX	S/V	15	14	14	13	13	13	12	11	10	9	8	8	8	8	8	8
	N	15	14	14	13	13	13	13	13	12	12	12	12	12	12	12	12

N = normal pattern

S/V = small-car pattern

model year 1975, however, a variety of different vehicles are being produced, especially if note is taken of the special emissions configurations for California. To get detailed data on these various configurations well in advance of the new model introductions (i.e., in June and July of 1974), an extensive study of the EPA and California certification tests was undertaken. From this study, a composite estimate of the 1975 models by configuration is obtained, as shown in Table F5. To maintain realism in the scenarios, all scenarios containing 1975 standards (Scenario C and beyond) maintain this percentage distribution by configuration class for the 1975 model year cars.

The complete set of basic scenarios follow. Configuration numbers refer back to Table 3-2, with the class numbers corresponding to the number of the mini-compact car in each class. Listed in Table F5 are the estimated number of cars to be sold in that year in thousands of units. The total number of car sales indicated at the bottom of each column may differ slightly from column totals as a result of round-off errors.

TABLE F5

Projected 1975 Model Year Sales by Configuration Class

(Numbers are the percentage of cars in the selected size with the configuration indicated.)

	CMVE Configuration Class			
Vehicle	29	36	43	50
11 Mini	0	90	0	10
22 Subcompact	44	46	5	5
33 Compact	37	53	7	3
45 Inter-A	0	65	31	4
46 Inter-B	0	5	87	8
57 Standard	0	56	39	5
68 Luxury	0	75	18	7

Source: EPA and California certification data.

		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
22.	11111409	0	0	0	0	0	88	184	286	296	306	317	328	340	352	364	377
23.	21112409	0	506	838	773	776	892	1016	1145	1286	1433	1484	1536	1589	1645	1702	1762
24.	34111409	924	1040	1025	966	948	1070	1200	1333	1484	1638	1801	1865	1930	1997	2068	2140
25.	44115409	1350	1551	1677	1740	1552	1605	1662	1721	1781	1844	1908	1974	2044	2116	2189	2266
26.	44116409	2276	2502	2702	2900	2501	2493	2494	2390	2473	2458	2544	2633	2725	2821	2920	3021
27.	54117409	1493	1648	1770	1931	1638	1606	1477	1433	1385	1330	1272	1316	1362	1410	1460	1510
28.	54113409	1155	1214	1304	1353	1206	1160	1200	1242	1186	1229	1272	1316	1362	1410	1460	1510
TOTAL POPULATION		7215	8676	9321	9659	8625	8927	9240	9563	9898	10244	10603	10974	11358	11756	12167	12593

Reproduced from best available copy.

```
                          1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

  1.    11111655             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  2.    21112655             0    40   251     0     0     0     0     0     0     0     0     0     0     0     0     0
  3.    34113656             0   104   307     0     0     0     0     0     0     0     0     0     0     0     0     0
  4.    44115656             0   155   503     0     0     0     0     0     0     0     0     0     0     0     0     0
  5.    44116656             0   260   810     0     0     0     0     0     0     0     0     0     0     0     0     0
  6.    54117656             0   164   531     0     0     0     0     0     0     0     0     0     0     0     0     0
  7.    64118655             0   121   391     0     0     0     0     0     0     0     0     0     0     0     0     0

  8.    11111655             0     0     0     0     0    31    66   102   106   110   114   118   122   126   131   135
  9.    21112655             0     0    75   278   279   321   365   412   462   515   534   552   572   592   612   634
 10.    34113655             0     0    92   347   341   385   432   481   534   589   648   671   694   718   744   770
 11.    44115655             0     0   150   626   558   578   598   619   641   663   686   710   735   761   788   815
 12.    44116655             0     0   243  1044   900   899   897   860   890   864   915   947   980  1015  1051  1087
 13.    54117655             0     0   159   695   589   578   531   515   493   478   457   473   490   507   525   543
 14.    64118655             0     0   117   437   434   417   432   447   426   442   457   473   490   507   525   543

 15.    11111655             0     0     0     0     0    47    99   154   159   165   171   177   183   190   196   203
 16.    21112655             0     0   112   417   419   481   548   618   694   773   801   829   858   888   919   951
 17.    34113655             0     0   138   521   511   577   648   722   801   884   972  1007  1042  1078  1116  1155
 18.    44115655             0     0   226   939   838   867   897   929   961   995  1030  1065  1103  1142  1182  1223
 19.    44116655             0     0   364  1566  1350  1348  1346  1290  1335  1327  1373  1421  1471  1523  1576  1631
 20.    54117655             0     0   238  1043   884   867   797   773   747   718   686   710   735   761   788   815
 21.    64118655             0     0   176   730   651   626   648   670   640   663   686   710   735   761   788   815

 22.    11111469             0     0     0     0     0     8    18    28    29    30    31    32    34    35    36    37
 23.    21112469             0   545   398    77    77    89   101   114   128   143   148   153   158   164   170   176
 24.    34113469           924   936   436    96    94   106   120   133   148   163   180   186   192   199   206   214
 25.    44115469          1350  1435   736   174   155   160   166   172   178   184   190   197   204   211   218   226
 26.    44116469          2276  2342  1283   290   250   249   249   238   247   245   254   263   272   282   292   302
 27.    54117469          1499  1483   840   193   163   160   147   143   138   132   127   131   136   140   146   150
 28.    64118469          1066  1092   519   135   120   116   120   124   118   122   127   131   136   140   146   150

TOTAL POPULATION          7115  8676  9321  9669  8625  8927  9240  9563  9398 10244 10603 10974 11358 11756 12167 12593




                                                                          SCENARIO-B          PAGE  1      08/29/74
```

		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1.	11111556	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.	21112556	0	50	250	0	0	0	0	0	0	0	0	0	0	0	0	0
3.	34113556	0	125	306	0	0	0	0	0	0	0	0	0	0	0	0	0
4.	44115556	0	155	502	0	0	0	0	0	0	0	0	0	0	0	0	0
5.	44116055	0	259	810	0	0	0	0	0	0	0	0	0	0	0	0	0
6.	54117055	0	163	537	0	0	0	0	0	0	0	0	0	0	0	0	0
7.	64118056	0	120	390	0	0	0	0	0	0	0	0	0	0	0	0	0
8.	11111655	0	0	0	0	0	20	41	54	66	69	72	74	77	79	82	85
9.	21112555	0	0	74	276	252	201	230	259	291	324	336	347	360	372	385	399
10.	34113655	0	0	90	346	308	242	272	303	336	371	408	422	437	452	468	485
11.	44115655	0	0	150	625	505	364	376	290	403	417	432	447	463	479	496	514
12.	44116655	0	0	243	1043	815	556	565	541	560	557	576	596	618	639	661	685
13.	54117555	0	0	153	695	534	364	334	324	313	301	288	298	308	319	330	342
14.	64118655	0	0	116	436	393	262	272	281	269	278	288	298	308	319	330	342
15.	11111655	0	0	0	0	0	30	62	97	100	104	108	111	115	119	123	127
16.	21112555	0	0	112	415	379	302	345	339	437	487	504	521	540	559	578	599
17.	34112655	0	0	136	520	464	363	408	454	504	557	612	633	656	679	703	727
18.	44115555	0	0	225	938	759	546	564	585	605	626	648	671	695	719	744	771
19.	44116655	0	0	364	1565	1223	849	847	812	841	835	865	895	927	959	992	1028
20.	54117555	0	0	238	1042	802	545	502	487	470	452	432	447	463	479	495	514
21.	64118655	0	0	174	730	590	394	403	422	403	417	432	447	463	479	495	514
22.	11111469	0	0	0	0	0	5	11	18	18	19	20	20	21	22	22	23
23.	21112469	0	544	396	76	59	50	64	72	80	90	93	96	100	103	107	110
24.	34113469	423	433	485	75	35	67	75	84	93	103	113	117	121	125	130	134
25.	44115469	1350	1403	795	173	140	101	104	108	112	116	120	124	128	133	137	142
26.	44115469	2274	2340	1283	289	226	157	156	150	155	154	160	165	171	177	183	190
27.	54117469	1493	1481	839	192	148	101	92	90	87	83	80	82	85	88	91	95
28.	64118469	1356	1391	619	135	109	72	75	78	74	77	80	82	85	88	91	95
29.	11121345		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	21122345	0	0	0	0	31	144	124	0	0	0	0	0	0	0	0	0
31.	34123346	0	0	0	0	32	146	123	0	0	0	0	0	0	0	0	0
32.	44125346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33.	44125346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34.	54127345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35.	64128346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36.	11121346	0	0	0	0	0	28	45	0	0	0	0	0	0	0	0	0
37.	21122346	0	0	0	0	32	151	149	0	0	0	0	0	0	0	0	0
38.	34123346	0	0	0	0	40	204	176	0	0	0	0	0	0	0	0	0
39.	44125346	0	0	0	0	92	385	249	0	0	0	0	0	0	0	0	0
40.	44125346	0	0	0	0	11	40	34	0	0	0	0	0	0	0	0	0
41.	54127346	0	0	0	0	84	332	229	0	0	0	0	0	0	0	0	0
42.	64128346	0	0	0	0	3	311	[illegible]	0		0	0	0	0	0	0	0

Reproduced from best available copy.

```
                     1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985

 43.  11121234          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 44.  21122234          0    0    0    0    3   16   14    0    0    0    0    0    0    0    0    0
 45.  34123234          0    0    0    0    6   27   23    0    0    0    0    0    0    0    0    0
 46.  44125234          0    0    0    0   44  183  142    0    0    0    0    0    0    0    0    0
 47.  44126234          0    0    0    0  200  303  602    0    0    0    0    0    0    0    0    0
 48.  54127234          0    0    0    0   58  231  159    0    0    0    0    0    0    0    0    0
 49.  64128234          0    0    0    0   19   77   59    0    0    0    0    0    0    0    0    0

 50.  11121124          0    0    0    0    0    3   13   39    0    0    0    0    0    0    0    0
 51.  21122124          0    0    0    0    3   16   79  222    0    0    0    0    0    0    0    0
 52.  34123124          0    0    0    0    2   11  120  371    0    0    0    0    0    0    0    0
 53.  44125124          0    0    0    0    5   23  171  477    0    0    0    0    0    0    0    0
 54.  44126124          0    0    0    0   18   73  285  663    0    0    0    0    0    0    0    0
 55.  54127124          0    0    0    0    7   29  156  398    0    0    0    0    0    0    0    0
 56.  64128124          0    0    0    0    7   30  134  345    0    0    0    0    0    0    0    0

 71.  11121121          0    0    0    0    0    0    0   13   54   56   58   60   62   64   67   69
 72.  21122121          0    0    0    0    0    0    0   63  303  311  294  284  294  304  314  326
 73.  34123121          0    0    0    0    0    0    0  110  480  468  449  404  383  369  382  396
 74.  44125121          0    0    0    0    0    0    0  143  575  527  475  428  406  391  404  419
 75.  44126121          0    0    0    0    0    0    0  198  799  704  635  571  541  521  540  558
 76.  54127121          0    0    0    0    0    0    0  118  447  381  317  279  239  208  216  223
 77.  64128121          0    0    0    0    0    0    0  133  377  323  270  230  188  156  162  167

134.  11141122          0    0    0    0    0    0    8   39    0    0    0    0    0    0    0    0
135.  21142122          0    0    0    0    0    0   28   95    0    0    0    0    0    0    0    0
136.  34143122          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
137.  44145122          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
138.  44146122          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
139.  54147122          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
140.  64148122          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

141.  11141121          0    0    0    0    0    0    0   13   54   56   58   60   62   64   67   69
142.  21142121          0    0    0    0    0    0    0   37  172  218  253  284  294  304  314  326
143.  34143121          0    0    0    0    0    0    0   12   63  136  216  284  329  369  382  396
144.  44145121          0    0    0    0    0    0    0   15   82  153  229  301  349  391  404  419
145.  44146121          0    0    0    0    0    0    0   22  114  204  305  401  466  521  540  558
146.  54147121          0    0    0    0    0    0    0   13   63  110  152  206  264  312  324  334
147.  64148121          0    0    0    0    0    0    0   11   60  130  199  255  314  364  378  390
```

		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1.	11111655	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.	21112655	0	60	251	0	0	0	0	0	0	0	0	0	0	0	0	0
3.	34113655	0	104	307	0	0	0	0	0	0	0	0	0	0	0	0	0
4.	44115655	0	156	503	0	0	0	0	0	0	0	0	0	0	0	0	0
5.	44116655	0	260	810	0	0	0	0	0	0	0	0	0	0	0	0	0
6.	54117655	0	164	551	0	0	0	0	0	0	0	0	0	0	0	0	0
7.	64118655	0	121	391	0	0	0	0	0	0	0	0	0	0	0	0	0
8.	11111655	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.	21112655	0	0	75	278	209	0	0	0	0	0	0	0	0	0	0	0
10.	34113655	0	0	92	347	255	0	0	0	0	0	0	0	0	0	0	0
11.	44115655	0	0	150	626	419	0	0	0	0	0	0	0	0	0	0	0
12.	44116655	0	0	243	1044	675	0	0	0	0	0	0	0	0	0	0	0
13.	54117655	0	0	159	695	442	0	0	0	0	0	0	0	0	0	0	0
14.	64118655	0	0	117	487	325	0	0	0	0	0	0	0	0	0	0	0
15.	11111655	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.	21112655	0	0	112	417	314	0	0	0	0	0	0	0	0	0	0	0
17.	34113655	0	0	138	521	383	0	0	0	0	0	0	0	0	0	0	0
18.	44115655	0	0	226	939	628	0	0	0	0	0	0	0	0	0	0	0
19.	44116655	0	0	354	1555	1013	0	0	0	0	0	0	0	0	0	0	0
20.	54117655	0	0	238	1043	663	0	0	0	0	0	0	0	0	0	0	0
21.	64118655	0	0	176	730	488	0	0	0	0	0	0	0	0	0	0	0
22.	11111469	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23.	21112469	0	545	398	77	58	0	0	0	0	0	0	0	0	0	0	0
24.	34113469	924	930	486	96	71	0	0	0	0	0	0	0	0	0	0	0
25.	44115469	1359	1405	796	174	116	0	0	0	0	0	0	0	0	0	0	0
26.	44116469	2276	2342	1243	290	187	0	0	0	0	0	0	0	0	0	0	0
27.	54117469	1493	1483	840	193	122	0	0	0	0	0	0	0	0	0	0	0
28.	64118469	1766	1092	619	135	90	0	0	0	0	0	0	0	0	0	0	0
29.	11121346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	21122346	0	0	0	0	85	392	447	534	565	630	652	675	699	723	748	775
31.	34123346	0	0	0	0	87	395	444	495	549	606	666	690	714	738	765	791
32.	44125346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33.	44126346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34.	54127346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35.	64128346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36.	11121346	0	0	0	0	0	79	165	257	266	275	285	295	306	316	327	339
37.	21122346	0	0	0	0	89	410	467	527	551	659	682	706	730	756	782	810
38.	34123346	0	0	0	0	125	567	636	709	786	868	954	988	1022	1058	1096	1134
39.	44125346	0	0	0	0	252	1043	1080	1118	1157	1198	1240	1283	1328	1375	1422	1472
40.	44126346	0	0	0	0	31	124	124	119	123	122	127	131	136	141	146	151
41.	54127346	0	0	0	0	224	498	427	802	775	744	712	736	762	789	817	845
42.	64128346	0	0	0	0	225	870	900	931	889	921	954	987	1021	1057	1095	1132

Reproduced from best available copy.

```
                          1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

 43.   11121234              0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 44.   21122234              0     0     0     0     9    44    53    57    64    71    74    76    79    82    85    88
 45.   34123234              0     0     0     0    15    74    84    93   103   114   125   130   135   139   144   149
 46.   44125234              0     0     0     0   120   497   515   533   552   571   591   611   633   655   678   702
 47.   44126234              0     0     0     0   543  2173  2169  2079  2151  2138  2213  2293  2370  2454  2540  2629
 48.   54127234              0     0     0     0   159   626   576   553   540   518   496   513   531   549   569   588
 49.   54128234              0     0     0     0    54   208   216   223   213   221   228   236   245   253   262   271

 50.   11121124              0     0     0     0     3     8    18    23    29    30    31    32    34    35    36    37
 51.   21122124              0     0     0     0     9    44    50    57    64    71    74    76    79    82    85    88
 52.   34123124              0     0     0     0     7    32    36    40    44    49    54    55    57    59    62    64
 53.   44125124              0     0     0     0    15    64    66    68    71    73    76    78    81    84    87    90
 54.   44126124              0     0     0     0    53   199   199   191   197   196   203   210   217   225   233   241
 55.   54127124              0     0     0     0    20    80    73    71    59    66    63    65    68    70    73    75
 56.   54128124              0     0     0     0    21    81    84    86    83    86    89    92    95    98   102   105

TOTAL POPULATION          7115  8676  9321  9659  8625  8927  9240  9563  9898 10244 10603 10974 11358 11756 12167 12593
```

		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1.	11111655	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.	21112656	0	60	250	0	0	0	0	0	0	0	0	0	0	0	0	0
3.	34113656	0	173	306	0	0	0	0	0	0	0	0	0	0	0	0	0
4.	44115656	0	155	502	0	0	0	0	0	0	0	0	0	0	0	0	0
5.	44116655	0	259	810	0	0	0	0	0	0	0	0	0	0	0	0	0
6.	54117656	0	163	530	0	0	0	0	0	0	0	0	0	0	0	0	0
7.	64118655	0	120	390	0	0	0	0	0	0	0	0	0	0	0	0	0
8.	11111655	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.	21112655	0	0	74	276	208	0	0	0	0	0	0	0	0	0	0	0
10.	34113655	0	0	90	346	255	0	0	0	0	0	0	0	0	0	0	0
11.	44115655	0	0	150	625	417	0	0	0	0	0	0	0	0	0	0	0
12.	44116655	0	0	243	1043	674	0	0	0	0	0	0	0	0	0	0	0
13.	54117655	0	0	158	695	441	0	0	0	0	0	0	0	0	0	0	0
14.	64118655	0	0	116	436	325	0	0	0	0	0	0	0	0	0	0	0
15.	11111555	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.	21112655	0	0	112	415	313	0	0	0	0	0	0	0	0	0	0	0
17.	34113655	0	0	136	520	383	0	0	0	0	0	0	0	0	0	0	0
18.	44115655	0	0	225	938	627	0	0	0	0	0	0	0	0	0	0	0
19.	44115555	0	0	364	1565	1011	0	0	0	0	0	0	0	0	0	0	0
20.	54117555	0	0	238	1042	662	0	0	0	0	0	0	0	0	0	0	0
21.	64118655	0	0	174	730	487	0	0	0	0	0	0	0	0	0	0	0
22.	11111469	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23.	21112469	0	544	396	76	57	0	0	0	0	0	0	0	0	0	0	0
24.	34113469	923	933	485	95	70	0	0	0	0	0	0	0	0	0	0	0
25.	44115469	1350	1403	795	173	116	0	0	0	0	0	0	0	0	0	0	0
26.	44116469	2274	2340	1283	299	187	0	0	0	0	0	0	0	0	0	0	0
27.	54117459	1493	1481	839	132	122	0	0	0	0	0	0	0	0	0	0	0
28.	64118469	1066	1091	619	135	90	0	0	0	0	0	0	0	0	0	0	0
29.	11121346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	21122346	0	0	0	0	84	330	405	317	356	396	410	425	440	455	471	488
31.	34123346	0	0	0	0	87	345	402	311	345	381	419	434	449	465	481	498
32.	44125346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33.	44126346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34.	54127346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35.	64128346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36.	[illegible]	0	0	0	0	0	78	140	162	167	173	180	185	192	198	206	213
37.	[illegible]	0	0	0	0	38	424	423	332	372	414	429	444	460	476	493	510
38.	[illegible]	0	0	0	0	104	556	576	446	493	546	601	622	544	565	690	714
39.	[illegible]	0	0	0	0	[illegible]	1042	978	734	724	754	780	838	837	865	895	928
40.	[illegible]	0	[illegible]	0	0	30	224	117	75	77	77	80	82	85	88	91	95
41.	[illegible]	0	[illegible]	0	0	278	338	749	535	439	459	448	464	480	497	514	533
42.	[illegible]	0	[illegible]	0	0	525	455	810	745	561	579	600	621	543	566	688	714

Reproduced from best available copy.

		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
[illegible]	[illegible]	0	[illegible]	0	0	0	0	0	0	0	[illegible]	[illegible]	0	0	[illegible]	[illegible]	0
44.	21122234	0	0	0	0	9	44	46	35	40	45	46	48	50	51	53	55
45.	34123234	0	0	0	0	16	74	75	59	65	72	79	82	85	88	91	94
46.	44125234	0	0	0	0	119	436	466	336	347	359	372	385	399	412	427	442
47.	44126234	0	0	0	0	541	2172	1967	1309	1355	1346	1393	1442	1493	1545	1599	1656
48.	54127234	0	0	0	0	156	625	521	351	340	326	312	323	334	346	358	371
49.	64128234	0	0	0	0	53	208	195	143	134	139	144	149	154	159	165	171
50.	11121124	0	0	0	0	3	8	24	57	18	19	20	20	21	22	22	23
51.	21122124	0	0	0	0	9	44	111	253	40	45	46	48	50	51	53	55
52.	34123124	0	0	0	0	6	31	142	396	28	30	34	35	36	37	39	40
53.	44125124	0	0	0	0	14	53	212	520	44	46	48	49	51	53	55	57
54.	44126124	0	0	0	0	49	198	410	783	124	123	128	132	137	142	147	152
55.	54127124	0	0	0	0	19	79	202	443	43	41	40	41	42	44	45	47
56.	64128124	0	0	0	0	20	81	136	399	52	54	56	58	60	62	64	66
71.	11121121	0	0	0	0	0	0	0	13	54	56	58	60	62	64	67	69
72.	21122121	0	0	0	0	0	0	0	68	303	311	294	284	294	304	314	326
73.	34123121	0	0	0	0	0	0	0	110	460	468	449	404	383	369	382	396
74.	44125121	0	0	0	0	0	0	0	143	575	527	475	428	406	391	404	419
75.	44126121	0	0	0	0	0	0	0	198	799	734	635	571	541	521	540	558
76.	54127121	0	0	0	0	0	0	0	118	447	331	317	279	239	208	216	223
77.	64128121	0	0	0	0	0	0	0	103	377	323	270	230	188	156	162	167
134.	11141122	0	0	0	0	0	0	8	39	0	0	0	0	0	0	0	0
135.	21142122	0	0	0	0	0	0	23	95	0	0	0	0	0	0	0	0
136.	34143122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
137.	44145122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
138.	44146122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.	54147122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140.	64148122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
141.	11141121	0	0	0	0	0	0	0	13	54	56	58	60	62	64	67	69
142.	21142121	0	0	0	0	0	0	0	37	172	218	253	284	294	304	314	326
143.	34143121	0	0	0	0	0	0	0	12	68	136	216	284	329	369	382	396
144.	44145121	0	0	0	0	0	0	0	15	92	153	229	301	349	391	404	419
145.	44146121	0	0	0	0	0	0	0	22	114	204	305	401	466	521	540	558
146.	54147121	0	0	0	0	0	0	0	13	53	110	152	206	264	312	324	334
147.	64148121	0	0	0	0	0	0	0	11	50	130	199	255	314	364	378	390

SCENARIO-C'J'   PAGE 2 08/29/74

		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1.	11111656	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.	21112655	0	40	251	0	0	0	0	0	0	0	0	0	0	0	0	0
3.	34113650	0	124	307	0	0	0	0	0	0	0	0	0	0	0	0	0
4.	44115655	0	155	503	0	0	0	0	0	0	0	0	0	0	0	0	0
5.	44115655	0	260	810	0	0	0	0	0	0	0	0	0	0	0	0	0
6.	54117655	0	164	531	0	0	0	0	0	0	0	0	0	0	0	0	0
7.	54118655	0	121	391	0	0	0	0	0	0	0	0	0	0	0	0	0
8.	11111655	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.	21112655	0	0	75	273	239	0	0	0	0	0	0	0	0	0	0	0
10.	34113655	0	0	42	347	255	0	0	0	0	0	0	0	0	0	0	0
11.	44115655	0	0	150	626	419	0	0	0	0	0	0	0	0	0	0	0
12.	44116655	0	0	243	1044	675	0	0	0	0	0	0	0	0	0	0	0
13.	54117655	0	0	159	730	455	0	0	0	0	0	0	0	0	0	0	0
14.	54118655	0	0	117	452	302	0	0	0	0	0	0	0	0	0	0	0
15.	11111655	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.	21112655	0	0	112	417	314	0	0	0	0	0	0	0	0	0	0	0
17.	34113655	0	0	138	521	383	0	0	0	0	0	0	0	0	0	0	0
18.	44115655	0	0	226	939	628	0	0	0	0	0	0	0	0	0	0	0
19.	44116655	0	0	304	1566	1013	0	0	0	0	0	0	0	0	0	0	0
20.	54117655	0	0	239	1095	698	0	0	0	0	0	0	0	0	0	0	0
21.	54118655	0	0	176	678	454	0	0	0	0	0	0	0	0	0	0	0
22.	11111469	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23.	21112469	0	545	298	77	53	0	0	0	0	0	0	0	0	0	0	0
24.	34113469	424	437	436	96	71	0	0	0	0	0	0	0	0	0	0	0
25.	44115469	1350	1405	796	174	116	0	0	0	0	0	0	0	0	0	0	0
26.	44116469	2276	2242	1283	290	187	0	0	0	0	0	0	0	0	0	0	0
27.	54117469	1493	1463	840	202	129	0	0	0	0	0	0	0	0	0	0	0
28.	54118469	1066	1092	619	125	84	0	0	0	0	0	0	0	0	0	0	0
29.	11121346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	21122346	0	0	0	0	85	431	528	630	740	855	979	1061	1099	1137	1177	1218
31.	34123346	0	0	0	0	87	429	512	601	695	795	902	974	1038	1043	1080	1117
32.	44125346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33.	44126345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34.	54127346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35.	54128346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36.	11121345	0	0	0	0	0	79	248	429	533	644	763	789	817	846	875	905
37.	21122345	0	0	0	0	89	451	552	653	773	894	1023	1109	1149	1189	1230	1273
38.	34123345	0	0	0	0	125	614	734	861	996	1139	1292	1395	1444	1495	1547	1601
39.	44125346	0	0	0	0	292	1102	1201	1305	1415	1531	1653	1711	1771	1833	1898	1963
40.	44126345	0	0	0	0	31	116	106	95	89	76	63	50	62	64	66	69
41.	54127345	0	0	0	0	241	449	724	587	442	343	237	193	190	197	203	211
42.	64128345		0	0	0	210	870	431	787	741	690	636	657	681	705	729	754

Reproduced from best available copy.

```
                          1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

 43.    11121234            0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 44.    21122234            0     0     0     0     9    49    50    71    84    97   111   120   124   129   133   138
 45.    34123234            0     0     0     0    16    31    96   113   131   150   170   184   190   197   204   211
 46.    44125234            0     0     0     0   120   525   572   622   674   730   788   816   844   874   905   936
 47.    44126234            0     0     0     0   543  2018  1847  1663  1549  1336  1106  1049  1086  1124  1163  1204
 48.    54127234            0     0     0     0   163   591   504   403   308   239   165   127   132   137   141   147
 49.    54128234            0     0     0     0    50   208   199   188   176   165   152   157   163   169   175   181

 50.    11121124            0     0     0     0     0     6    27    47    59    71    84    87    90    94    97   100
 51.    21122124            0     0     0     0     9    49    60    71    84    97   111   120   124   129   133   138
 52.    34123124            0     0     0     0     7    34    41    48    56    64    73    78    81    84    87    90
 53.    44125124            0     0     0     0    15    67    73    80    87    94   101   105   108   112   116   120
 54.    44126124            0     0     0     0    50   135   169   152   142   122   101    96    99   103   106   110
 55.    54127124            0     0     0     0    21    75    64    52    39    30    21    16    17    17    18    18
 56.    54128124            0     0     0     0    19    31    77    73    69    64    59    61    63    65    68    70

TOTAL POPULATION         7115  8676  9321  9669  8625  8927  9240  9563  9898 10244 10603 10974 11358 11756 12167 12593
```

```
                     1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1991  1982  1983  1984  1985

 1.   11111656          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 2.   21112656          0    60   251     0     0     0     0     0     0     0     0     0     0     0     0     0
 3.   34113656          0   104   307     0     0     0     0     0     0     0     0     0     0     0     0     0
 4.   44115656          0   156   503     0     0     0     0     0     0     0     0     0     0     0     0     0
 5.   44116656          0   260   810     0     0     0     0     0     0     0     0     0     0     0     0     0
 6.   54117656          0   164   531     0     0     0     0     0     0     0     0     0     0     0     0     0
 7.   64118656          0   121   391     0     0     0     0     0     0     0     0     0     0     0     0     0

 8.   11111655          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 9.   21112655          0     0    75   278   209     0     0     0     0     0     0     0     0     0     0     0
10.   34113655          0     0    92   347   255     0     0     0     0     0     0     0     0     0     0     0
11.   44115655          0     0   150   626   419     0     0     0     0     0     0     0     0     0     0     0
12.   44116655          0     0   243  1044   675     0     0     0     0     0     0     0     0     0     0     0
13.   54117655          0     0   159   695   442     0     0     0     0     0     0     0     0     0     0     0
14.   64118655          0     0   117   487   325     0     0     0     0     0     0     0     0     0     0     0

15.   11111655          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
16.   21112655          0     0   112   417   314     0     0     0     0     0     0     0     0     0     0     0
17.   34113655          0     0   138   521   383     0     0     0     0     0     0     0     0     0     0     0
18.   44115655          0     0   226   939   628     0     0     0     0     0     0     0     0     0     0     0
19.   44116655          0     0   364  1566  1013     0     0     0     0     0     0     0     0     0     0     0
20.   54117655          0     0   238  1043   663     0     0     0     0     0     0     0     0     0     0     0
21.   64118655          0     0   176   730   488     0     0     0     0     0     0     0     0     0     0     0

22.   11111469          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
23.   21112469          0   545   398    77    58     0     0     0     0     0     0     0     0     0     0     0
24.   34113469        924   936   486    96    71     0     0     0     0     0     0     0     0     0     0     0
25.   44115469       1350  1405   796   174   116     0     0     0     0     0     0     0     0     0     0     0
26.   44116469       2276  2342  1283   290   187     0     0     0     0     0     0     0     0     0     0     0
27.   54117469       1493  1483   840   193   122     0     0     0     0     0     0     0     0     0     0     0
28.   64118469       1066  1092   619   135    90     0     0     0     0     0     0     0     0     0     0     0

29.   11121346          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
30.   21122346          0     0     0     0    85   392   335     0     0     0     0     0     0     0     0     0
31.   34123346          0     0     0     0    87   395   333     0     0     0     0     0     0     0     0     0
32.   44125346          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
33.   44126346          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
34.   54127346          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
35.   64128346          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

36.   11121346          0     0     0     0     0    79   124     0     0     0     0     0     0     0     0     0
37.   21122346          0     0     0     0    89   410   350     0     0     0     0     0     0     0     0     0
38.   34123346          0     0     0     0   125   567   477     0     0     0     0     0     0     0     0     0
39.   44125346          0     0     0     0   252  1043   810     0     0     0     0     0     0     0     0     0
40.   44126346          0     0     0     0    31   124    93     0     0     0     0     0     0     0     0     0
41.   54127346          0     0     0     0   229   899   620     0     0     0     0     0     0     0     0     0
42.   64128346          0     0     0     0   225   870   675     0     0     0     0     0     0     0     0     0


                                                              SCENARIO-E          PAGE  1      01/21/75
```

```
                              1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985
  43.   11121234                 0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  44.   21122234                 0     0     0     0     9    44    38     0     0     0     0     0     0     0     0     0
  45.   34123234                 0     0     0     0    16    74    63     0     0     0     0     0     0     0     0     0
  46.   44125234                 0     0     0     0   120   497   386     0     0     0     0     0     0     0     0     0
  47.   44126234                 0     0     0     0   543  2173  1627     0     0     0     0     0     0     0     0     0
  48.   54127234                 0     0     0     0   159   626   432     0     0     0     0     0     0     0     0     0
  49.   64128234                 0     0     0     0    54   208   162     0     0     0     0     0     0     0     0     0

  50.   11121124                 0     0     0     0     0     8    36   143   148   153   158   164   170   176   182   188
  51.   21122124                 0     0     0     0     9    44   165   573   643   716   742   768   794   822   851   881
  52.   34123124                 0     0     0     0     7    32   327  1338  1484  1638  1801  1865  1930  1997  2068  2140
  53.   44125124                 0     0     0     0    15    64   464  1721  1781  1844  1908  1974  2044  2116  2189  2266
  54.   44126124                 0     0     0     0    50   199   772  2390  2473  2458  2544  2633  2725  2821  2920  3021
  55.   54127124                 0     0     0     0    20    80   424  1433  1385  1330  1272  1316  1362  1410  1460  1510
  56.   64128124                 0     0     0     0    21    81   363  1242  1186  1229  1272  1316  1362  1410  1460  1510

 134.   11141122                 0     0     0     0     0     0    23   143   148   153   158   164   170   176   182   188
 135.   21142122                 0     0     0     0     0     0   127   573   643   716   742   768   794   822   851   881
 136.   34143122                 0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 137.   44145122                 0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 138.   44146122                 0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 139.   54147122                 0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 140.   64148122                 0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 TOTAL POPULATION             7115  8676  9321  9669  8625  8927  9240  9563  9898 10244 10603 10974 11358 11756 12167 12593
```

		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1.	11111656	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.	21112656	0	60	251	0	0	0	0	0	0	0	0	0	0	0	0	0
3.	34113656	0	104	307	0	0	0	0	0	0	0	0	0	0	0	0	0
4.	44115656	0	156	503	0	0	0	0	0	0	0	0	0	0	0	0	0
5.	44116656	0	260	810	0	0	0	0	0	0	0	0	0	0	0	0	0
6.	54117656	0	164	531	0	0	0	0	0	0	0	0	0	0	0	0	0
7.	64118656	0	121	391	0	0	0	0	0	0	0	0	0	0	0	0	0
8.	11111655	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.	21112655	0	0	75	278	209	0	0	0	0	0	0	0	0	0	0	0
10.	34113655	0	0	92	347	255	0	0	0	0	0	0	0	0	0	0	0
11.	44115655	0	0	150	626	419	0	0	0	0	0	0	0	0	0	0	0
12.	44116655	0	0	243	1044	675	0	0	0	0	0	0	0	0	0	0	0
13.	54117655	0	0	159	695	442	0	0	0	0	0	0	0	0	0	0	0
14.	64118655	0	0	117	487	325	0	0	0	0	0	0	0	0	0	0	0
15.	11111655	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.	21112655	0	0	112	417	314	0	0	0	0	0	0	0	0	0	0	0
17.	34113655	0	0	138	521	383	0	0	0	0	0	0	0	0	0	0	0
18.	44115655	0	0	226	939	628	0	0	0	0	0	0	0	0	0	0	0
19.	44116655	0	0	364	1566	1013	0	0	0	0	0	0	0	0	0	0	0
20.	54117655	0	0	238	1043	663	0	0	0	0	0	0	0	0	0	0	0
21.	64118655	0	0	176	730	488	0	0	0	0	0	0	0	0	0	0	0
22.	11111469	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23.	21112469	0	545	398	77	58	0	0	0	0	0	0	0	0	0	0	0
24.	34113469	924	936	486	96	71	0	0	0	0	0	0	0	0	0	0	0
25.	44115469	1350	1405	796	174	116	0	0	0	0	0	0	0	0	0	0	0
26.	44116469	2276	2342	1283	290	187	0	0	0	0	0	0	0	0	0	0	0
27.	54117469	1493	1483	840	193	122	0	0	0	0	0	0	0	0	0	0	0
28.	64118469	1066	1092	619	135	90	0	0	0	0	0	0	0	0	0	0	0
29.	11121346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.	21122346	0	0	0	0	85	392	335	0	0	0	0	0	0	0	0	0
31.	34123346	0	0	0	0	87	395	333	0	0	0	0	0	0	0	0	0
32.	44125346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33.	44126346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34.	54127346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35.	64128346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36.	11121346	0	0	0	[illegible]	0	79	124	0	0	0	0	0	0	0	0	0
37.	21122346	0	0	0	0	89	410	350	0	0	0	0	0	0	0	0	0
38.	34123346	0	0	0	0	125	567	477	0	0	0	0	0	0	0	0	0
39.	44125346	0	0	0	0	252	1043	810	0	0	0	0	0	0	0	[illegible]	0
40.	44126346	0	0	0	0	31	124	93	0	0	0	0	0	0	0	0	0
41.	54127346	0	0	0	0	229	899	629	0	0	0	0	0	0	0	0	0
				0	0	[illegible]	[illegible]		931	[illegible]	921		87	1021	[illegible]	[illegible]	[illegible]

```
                          1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

  43.   11121234             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  44.   21122234             0     0     0     0     9    44    38     0     0     0     0     0     0     0     0     0
  45.   34123234             0     0     0     0    16    74    63     0     0     0     0     0     0     0     0     0
  46.   44125234             0     0     0     0   120   497   386     0     0     0     0     0     0     0     0     0
  47.   44126234             0     0     0     0   543  2173  1627     0     0     0     0     0     0     0     0     0
  48.   54127234             0     0     0     0   159   626   432     0     0     0     0     0     0     0     0     0
  49.   64128234             0     0     0     0    54   208   216   223   213   221   228   236   245   253   262   271

  50.   11121124             0     0     0     0     0     8    36   143   148   153   158   164   170   176   182   188
  51.   21122124             0     0     0     0     9    44   165   573   643   716   742   768   794   822   851   881
  52.   34123124             0     0     0     0     7    32   327  1338  1484  1638  1801  1865  1930  1997  2068  2140
  53.   44125124             0     0     0     0    15    64   464  1721  1781  1844  1908  1974  2044  2116  2189  2266
  54.   44126124             0     0     0     0    50   199   772  2390  2473  2458  2544  2633  2725  2821  2920  3021
  55.   54127124             0     0     0     0    20    80   424  1433  1385  1330  1272  1316  1362  1410  1460  1513
  56.   64128124             0     0     0     0    21    81    84    86    83    86    89    92    95    98   102   105

 134.   11141122             0     0     0     0     0     0    23   143   148   153   158   164   170   176   182   188
 135.   21142122             0     0     0     0     0   111   508   573   643   716   742   768   794   822   851   881
 136.   34143122             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 137.   44145122             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 138.   44146122             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 139.   54147122             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 140.   64148122             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

TOTAL POPULATION          7115  8676  9321  9669  8625  8927  9240  9563  9898 10244 10603 10974 11358 11756 12167 12593
```

```
                      1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

 1.   11111656           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 2.   21112656           0    60   251     0     0     0     0     0     0     0     0     0     0     0     0     0
 3.   34113656           0   104   307     0     0     0     0     0     0     0     0     0     0     0     0     0
 4.   44115656           0   156   503     0     0     0     0     0     0     0     0     0     0     0     0     0
 5.   44116656           0   260   810     0     0     0     0     0     0     0     0     0     0     0     0     0
 6.   54117656           0   164   531     0     0     0     0     0     0     0     0     0     0     0     0     0
 7.   64118656           0   121   391     0     0     0     0     0     0     0     0     0     0     0     0     0

 8.   11111655           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 9.   21112655           0     0    75   278   209     0     0     0     0     0     0     0     0     0     0     0
10.   34113655           0     0    92   347   255     0     0     0     0     0     0     0     0     0     0     0
11.   44115655           0     0   150   626   419     0     0     0     0     0     0     0     0     0     0     0
12.   44116655           0     0   243  1044   675     0     0     0     0     0     0     0     0     0     0     0
13.   54117655           0     0   159   695   442     0     0     0     0     0     0     0     0     0     0     0
14.   64118655           0     0   117   487   325     0     0     0     0     0     0     0     0     0     0     0

15.   11111655           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
16.   21112655           0     0   112   417   314     0     0     0     0     0     0     0     0     0     0     0
17.   34113655           0     0   138   521   383     0     0     0     0     0     0     0     0     0     0     0
18.   44115655           0     0   226   939   628     0     0     0     0     0     0     0     0     0     0     0
19.   44116655           0     0   364  1566  1013     0     0     0     0     0     0     0     0     0     0     0
20.   54117655           0     0   238  1043   663     0     0     0     0     0     0     0     0     0     0     0
21.   64118655           0     0   176   730   488     0     0     0     0     0     0     0     0     0     0     0

22.   11111469           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
23.   21112469           0   545   398    77    58     0     0     0     0     0     0     0     0     0     0     0
24.   34113469         924   936   486    96    71     0     0     0     0     0     0     0     0     0     0     0
25.   44115469        1350  1405   796   174   116     0     0     0     0     0     0     0     0     0     0     0
26.   44116469        2276  2342  1283   290   187     0     0     0     0     0     0     0     0     0     0     0
27.   54117469        1493  1483   840   193   122     0     0     0     0     0     0     0     0     0     0     0
28.   64118469        1066  1092   619   135    90     0     0     0     0     0     0     0     0     0     0     0

29.   11121346           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
30.   21122346           0     0     0     0    85   392   335     0     0     0     0     0     0     0     0     0
31.   34123346           0     0     0     0    87   395   333     0     0     0     0     0     0     0     0     0
32.   44125346           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
33.   44126346           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
34.   54127346           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
35.   64128346           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

36.   11121346           0     0     0     0     0    79   124     0     0     0     0     0     0     0     0     0
37.   21122345           0     0     0     0    89   410   350     0     0     0     0     0     0     0     0     0
38.   34123346           0     0     0     0   125   567   477     0     0     0     0     0     0     0     0     0
39.   44125346           0     0     0     0   252  1043   810     0     0     0     0     0     0     0     0     0
40.   44126346           0     0     0     0    31   124    93     0     0     0     0     0     0     0     0     0
41.   54127346           0     0     0     0   229   899   620     0     0     0     0     0     0     0     0     0
42.   64128346           0     0     0     0   225   870   675     0     0     0     0     0     0     0     0     0


                                                                          SCENARIO-ED         PAGE  1      01/21/75
```

```
                   1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

 43.   11121234       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 44.   21122234       0     0     0     0     9    44    38     0     0     0     0     0     0     0     0     0
 45.   34123234       0     0     0     0    15    74    63     0     0     0     0     0     0     0     0     0
 46.   44125234       0     0     0     0   120   497   386     0     0     0     0     0     0     0     0     0
 47.   44126234       0     0     0     0   543  2173  1627     0     0     0     0     0     0     0     0     0
 48.   54127234       0     0     0     0   159   626   432     0     0     0     0     0     0     0     0     0
 49.   64128234       0     0     0     0    54   208   162     0     0     0     0     0     0     0     0     0

 50.   11121124       0     0     0     0     0     8    36   143   148   153   158   164   170   176   182   188
 51.   21122124       0     0     0     0     9    44   208   762   829   895   897   898   901   921   953   986
 52.   34123124       0     0     0     0     7    32   318  1287  1383  1478  1571  1571  1572  1597  1654  1712
 53.   44125124       0     0     0     0    15    64   464  1708  1714  1719  1726  1746  1768  1798  1860  1926
 54.   44126124       0     0     0     0    50   199   772  2372  2380  2292  2302  2330  2357  2397  2482  2567
 55.   54127124       0     0     0     0    20    83   424  1433  1385  1321  1243  1273  1304  1339  1387  1434
 56.   64128124       0     0     0     0    21    81   363  1242  1186  1222  1243  1273  1304  1339  1387  1434

134.   11141122       0     0     0     0     0     0    23   143   148   153   158   164   170   176   182   188
135.   21142122       0     0     0     0     0     0    76   340   369   397   396   395   393   394   408   422
136.   34143122       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
137.   44145122       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
138.   44146122       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
139.   54147122       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
140.   64148122       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

190.   11631123       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
191.   21632123       0     0     0     0     0     0     7    42    86   139   189   241   293   328   340   352
192.   31633123       0     0     0     0     0     0     9    50   100   159   229   293   357   399   413   428
193.   44635123       0     0     0     0     0     0     0    12    66   124   181   226   275   317   328   339
194.   44636123       0     0     0     0     0     0     0    17    92   165   241   302   367   423   438   453
195.   54637123       0     0     0     0     0     0     0     0     0     6    28    42    57    70    73    75
196.   54638123       0     0     0     0     0     0     0     0     0     6    28    42    57    70    73    75

TOTAL POPULATION   7115  8676  9321  9669  8625  8927  9240  9563  9898 10244 10603 10974 11358 11756 12167 12593




                                                                  SCENARIO-ED        PAGE  2     01/21/75
```

```
                      1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

  1.   11111656          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  2.   21112656          0    60   251     0     0     0     0     0     0     0     0     0     0     0     0     0
  3.   34113656          0   104   307     0     0     0     0     0     0     0     0     0     0     0     0     0
  4.   44115656          0   156   503     0     0     0     0     0     0     0     0     0     0     0     0     0
  5.   44116656          0   260   810     0     0     0     0     0     0     0     0     0     0     0     0     0
  6.   54117656          0   164   531     0     0     0     0     0     0     0     0     0     0     0     0     0
  7.   64118656          0   121   391     0     0     0     0     0     0     0     0     0     0     0     0     0

  8.   11111655          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  9.   21112655          0     0    75   278   209     0     0     0     0     0     0     0     0     0     0     0
 10.   34113655          0     0    92   347   255     0     0     0     0     0     0     0     0     0     0     0
 11.   44115655          0     0   150   626   419     0     0     0     0     0     0     0     0     0     0     0
 12.   44116655          0     0   243  1044   675     0     0     0     0     0     0     0     0     0     0     0
 13.   54117655          0     0   159   695   442     0     0     0     0     0     0     0     0     0     0     0
 14.   64118655          0     0   117   487   325     0     0     0     0     0     0     0     0     0     0     0

 15.   11111655          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 16.   21112655          0     0   112   417   314     0     0     0     0     0     0     0     0     0     0     0
 17.   34113655          0     0   138   521   383     0     0     0     0     0     0     0     0     0     0     0
 18.   44115655          0     0   226   939   628     0     0     0     0     0     0     0     0     0     0     0
 19.   44116655          0     0   364  1566  1013     0     0     0     0     0     0     0     0     0     0     0
 20.   54117655          0     0   238  1043   663     0     0     0     0     0     0     0     0     0     0     0
 21.   64118655          0     0   176   730   488     0     0     0     0     0     0     0     0     0     0     0

 22.   11111469          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 23.   21112469          0   545   398    77    58     0     0     0     0     0     0     0     0     0     0     0
 24.   34113469        924   936   486    96    71     0     0     0     0     0     0     0     0     0     0     0
 25.   44115469       1350  1405   796   174   116     0     0     0     0     0     0     0     0     0     0     0
 26.   44116469       2276  2342  1283   290   187     0     0     0     0     0     0     0     0     0     0     0
 27.   54117469       1493  1483   840   193   122     0     0     0     0     0     0     0     0     0     0     0
 28.   64118469       1066  1092   619   135    90     0     0     0     0     0     0     0     0     0     0     0

 29.   11121346          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 30.   21122346          0     0     0     0    85   392   335     0     0     0     0     0     0     0     0     0
 31.   34123346          0     0     0     0    87   395   333     0     0     0     0     0     0     0     0     0
 32.   44125346          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 33.   44126346          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 34.   54127346          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 35.   64128346          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 36.   11121346          0     0     0     0     0    79   124     0     0     0     0     0     0     0     0     0
 37.   21122346          0     0     0     0    89   410   350     0     0     0     0     0     0     0     0     0
 38.   34123346          0     0     0     0   125   567   477     0     0     0     0     0     0     0     0     0
 39.   44125346          0     0     0     0   252  1043   810     0     0     0     0     0     0     0     0     0
 40.   44126346          0     0     0     0    31   124    93     0     0     0     0     0     0     0     0     0
 41.   54127346          0     0     0     0   229   899   620     0     0     0     0     0     0     0     0     0
 42.   64128346          0     0     0     0   225   870   675     0     0     0     0     0     0     0     0     0
```

```
                         1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

 43.   11121234             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 44.   21122234             0     0     0     0     9    44    38     0     0     0     0     0     0     0     0     0
 45.   34123234             0     0     0     0    16    74    63     0     0     0     0     0     0     0     0     0
 46.   44125234             0     0     0     0   120   497   386     0     0     0     0     0     0     0     0     0
 47.   44126234             0     0     0     0   543  2173  1627     0     0     0     0     0     0     0     0     0
 48.   54127234             0     0     0     0   159   626   432     0     0     0     0     0     0     0     0     0
 49.   64128234             0     0     0     0    54   208   162     0     0     0     0     0     0     0     0     0

 50.   11121124             0     0     0     0     0     8    59   286   296   306   317   328   340   352   364   377
 51.   21122124             0     0     0     0     9    44   208   762   829   895   897   898   901   921   953   986
 52.   34123124             0     0     0     0     7    32   318  1287  1383  1478  1571  1571  1572  1597  1654  1712
 53.   44125124             0     0     0     0    15    64   464  1708  1714  1719  1726  1746  1768  1798  1860  1926
 54.   44126124             0     0     0     0    50   199   772  2372  2380  2292  2302  2330  2357  2397  2482  2567
 55.   54127124             0     0     0     0    20    80   424  1433  1385  1323  1243  1273  1304  1339  1387  1434
 56.   64128124             0     0     0     0    21    81   363  1242  1186  1222  1243  1273  1304  1339  1387  1434

190.   11631123             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
191.   21632123             0     0     0     0     0     0    83   383   456   537   586   637   687   723   748   775
192.   31633123             0     0     0     0     0     0     9    50   100   159   229   293   357   399   413   428
193.   44635123             0     0     0     0     0     0     0    12    66   124   181   226   275   317   328   339
194.   44636123             0     0     0     0     0     0     0    17    92   165   241   302   367   423   438   453
195.   54637123             0     0     0     0     0     0     0     0     0     6    28    42    57    70    73    75
196.   64638123             0     0     0     0     0     0     0     0     0     6    28    42    57    70    73    75

TOTAL POPULATION         7115  8676  9321  9669  8625  8927  9240  9563  9898 10244 10603 10974 11358 11756 12167 12593
```

```
                   1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

  1.   11111656       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  2.   21112656       0    43   251     0     0     0     0     0     0     0     0     0     0     0     0     0
  3.   34113656       0   134   307     0     0     0     0     0     0     0     0     0     0     0     0     0
  4.   44115656       0   155   503     0     0     0     0     0     0     0     0     0     0     0     0     0
  5.   44116656       0   250   810     0     0     0     0     0     0     0     0     0     0     0     0     0
  6.   54117656       0   164   531     0     0     0     0     0     0     0     0     0     0     0     0     0
  7.   64118655       0   121   341     0     0     0     0     0     0     0     0     0     0     0     0     0

  8.   11111655       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  9.   21112555       0     0    75   273   229     0     0     0     0     0     0     0     0     0     0     0
 10.   34113655       0     0    92   347   255     0     0     0     0     0     0     0     0     0     0     0
 11.   44115555       0     0   150   626   419     0     0     0     0     0     0     0     0     0     0     0
 12.   44116655       0     0   243  1044   675     0     0     0     0     0     0     0     0     0     0     0
 13.   54117655       0     0   159   695   442     0     0     0     0     0     0     0     0     0     0     0
 14.   64118655       0     0   117   487   325     0     0     0     0     0     0     0     0     0     0     0

 15.   11111655       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 16.   21112655       0     0   112   417   314     0     0     0     0     0     0     0     0     0     0     0
 17.   34113655       0     0   138   521   383     0     0     0     0     0     0     0     0     0     0     0
 18.   44115655       0     0   226   939   628     0     0     0     0     0     0     0     0     0     0     0
 19.   44116655       0     0   364  1566  1013     0     0     0     0     0     0     0     0     0     0     0
 20.   54117655       0     0   238  1043   663     0     0     0     0     0     0     0     0     0     0     0
 21.   64113655       0     0   176   730   488     0     0     0     0     0     0     0     0     0     0     0

 22.   11111469       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 23.   21112469       0   545   398    77    58     0     0     0     0     0     0     0     0     0     0     0
 24.   34113469     924   936   486    96    71     0     0     0     0     0     0     0     0     0     0     0
 25.   44115469    1350  1405   796   174   116     0     0     0     0     0     0     0     0     0     0     0
 26.   44116469    2276  2342  1283   290   187     0     0     0     0     0     0     0     0     0     0     0
 27.   54117469    1453  1483   840   193   122     0     0     0     0     0     0     0     0     0     0     0
 28.   64118469    1366  1092   619   135    90     0     0     0     0     0     0     0     0     0     0     0

 29.   11121346       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 30.   21122346       0     0     0     0    35   392   335     0     0     0     0     0     0     0     0     0
 31.   34123346       0     0     0     0    87   395   333     0     0     0     0     0     0     0     0     0
 32.   44125346       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 33.   44126346       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 34.   54127346       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 35.   64128346       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 36.   11121346       0     0     0     0     0    79   124     0     0     0     0     0     0     0     0     0
 37.   21122346       0     0     0     0    37   410   350     0     0     0     0     0     0     0     0     0
 38.   34123346       0     0     0     0   125   567   477     0     0     0     0     0     0     0     0     0
 39.   44125346       0     0     0     0   252  1343   810     0     0     0     0     0     0     0     0     0
 40.   44126346       0     0     0     0    31   124    93     0     0     0     0     0     0     0     0     0
 41.   54127346       0     0     0     0   229   349   520     0     0     0     0     0     0     0     0     0
 42.   64128346       0     0     0     0   225   370   675     0     0     0     0     0     0     0     0     0

                                                                     SCENARIO-FS        PAGE  1   [illegible]
```

		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
43.	11121234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44.	21122234	0	0	0	0	9	44	38	0	0	0	0	0	0	0	0	0
45.	34123234	0	0	0	0	16	74	63	0	0	0	0	0	0	0	0	0
46.	44125234	0	0	0	0	120	497	386	0	0	0	0	0	0	0	0	0
47.	44126234	0	0	0	0	543	2173	1627	0	0	0	0	0	0	0	0	0
48.	54127234	0	0	0	0	159	626	432	0	0	0	0	0	0	0	0	0
49.	64128234	0	0	0	0	54	208	162	0	0	0	0	0	0	0	0	0
50.	11121124	0	0	0	0	0	8	59	278	260	244	229	219	214	208	205	207
51.	21122124	0	0	0	0	9	44	292	1117	1131	1146	1075	1029	1001	974	961	969
52.	34123124	0	0	0	0	7	32	327	1304	1335	1310	1305	1249	1215	1183	1168	1177
53.	44125124	0	0	0	0	15	64	464	1678	1567	1475	1383	1322	1287	1253	1236	1246
54.	44126124	0	0	0	0	50	199	772	2330	2176	1966	1844	1764	1716	1671	1649	1661
55.	54127124	0	0	0	0	20	80	424	1397	1218	1064	922	881	858	835	824	830
56.	64128124	0	0	0	0	21	81	363	1211	1043	983	922	881	858	835	824	830
85.	11221345	0	0	0	0	0	0	0	3	17	26	35	40	45	50	54	56
86.	21222345	0	0	0	0	0	0	0	14	73	125	166	188	210	234	255	264
87.	34223346	0	0	0	0	0	0	0	16	85	143	202	228	255	284	310	321
88.	44225346	0	0	0	0	0	0	0	21	102	161	214	241	270	301	328	339
89.	44226346	0	0	0	0	0	0	0	29	142	215	286	322	361	401	438	453
90.	54227346	0	0	0	0	0	0	0	17	79	116	143	161	180	200	219	226
91.	64228346	0	0	0	0	0	0	0	15	68	107	143	161	180	200	219	226
134.	11141122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135.	21142122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
136.	34143122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
137.	44145122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
138.	44146122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.	54147122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140.	64148122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
211.	11231124	0	0	0	0	0	0	0	3	18	34	51	68	80	93	103	113
212.	21232124	0	0	0	0	0	0	0	14	80	161	241	318	377	435	485	528
213.	34233124	0	0	0	0	0	0	0	16	92	184	292	386	458	529	589	642
214.	44235124	0	0	0	0	0	0	0	21	111	207	310	409	485	560	623	679
215.	44236124	0	0	0	0	0	0	0	29	154	276	413	546	647	747	832	906
216.	54237124	0	0	0	0	0	0	0	17	86	149	206	273	323	373	416	452
217.	64238124	0	0	0	0	0	0	0	15	74	138	206	273	323	373	416	452
TOTAL	POPULATION	7115	8676	9321	9669	8625	8927	9240	9563	9898	10244	10603	10974	11358	11756	12167	12593

```
                     1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

  1.   11111656         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  2.   21112656         0    60   251     0     0     0     0     0     0     0     0     0     0     0     0     0
  3.   34113656         0   104   307     0     0     0     0     0     0     0     0     0     0     0     0     0
  4.   44115656         0   156   503     0     0     0     0     0     0     0     0     0     0     0     0     0
  5    44116656         0   260   810     0     0     0     0     0     0     0     0     0     0     0     0     0
  6.   54117656         0   164   531     0     0     0     0     0     0     0     0     0     0     0     0     0
  7.   64118656         0   121   391     0     0     0     0     0     0     0     0     0     0     0     0     0

  8.   11111655         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  9.   21112655         0     0    75   278   209     0     0     0     0     0     0     0     0     0     0     0
 10.   34113655         0     0    92   347   255     0     0     0     0     0     0     0     0     0     0     0
 11.   44115655         0     0   150   626   419     0     0     0     0     0     0     0     0     0     0     0
 12.   44116655         0     0   243  1044   675     0     0     0     0     0     0     0     0     0     0     0
 13.   54117655         0     0   159   695   442     0     0     0     0     0     0     0     0     0     0     0
 14.   64118655         0     0   117   487   325     0     0     0     0     0     0     0     0     0     0     0

 15.   11111655         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 16.   21112655         0     0   112   417   314     0     0     0     0     0     0     0     0     0     0     0
 17.   34113655         0     0   138   521   383     0     0     0     0     0     0     0     0     0     0     0
 18.   44115655         0     0   226   939   628     0     0     0     0     0     0     0     0     0     0     0
 19.   44116655         0     0   364  1566  1013     0     0     0     0     0     0     0     0     0     0     0
 20.   54117655         0     0   238  1043   663     0     0     0     0     0     0     0     0     0     0     0
 21.   64118655         0     0   176   730   488     0     0     0     0     0     0     0     0     0     0     0

 22.   11111469         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 23.   21112469         0   545   398    77    58     0     0     0     0     0     0     0     0     0     0     0
 24.   34113469       924   936   486    96    71     0     0     0     0     0     0     0     0     0     0     0
 25.   44115469      1350  1405   796   174   116     0     0     0     0     0     0     0     0     0     0     0
 26.   44116469      2276  2342  1283   290   187     0     0     0     0     0     0     0     0     0     0     0
 27.   54117469      1493  1483   840   193   122     0     0     0     0     0     0     0     0     0     0     0
 28.   64118469      1066  1092   619   135    90     0     0     0     0     0     0     0     0     0     0     0

 29.   11121346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 30.   21122346         0     0     0     0    85   392   335     0     0     0     0     0     0     0     0     0
 31.   34123346         0     0     0     0    87   395   333     0     0     0     0     0     0     0     0     0
 32.   44125346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 33.   44126346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 34.   54127346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 35.   64128346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 36.   11121346         0     0     0     0     0    79   124     0     0     0     0     0     0     0     0     0
 37.   21122346         0     0     0     0    89   410   350     0     0     0     0     0     0     0     0     0
 38.   34123346         0     0     0     0   125   567   477     0     0     0     0     0     0     0     0     0
 39.   44125346         0     0     0     0   252  1043   810     0     0     0     0     0     0     0     0     0
 40.   44126346         0     0     0     0    31   124    93     0     0     0     0     0     0     0     0     0
 41.   54127346         0     0     0     0   229   899   620     0     0     0     0     0     0     0     0     0
 42.   64128346         0     0     0     0   225   870   675     0     0     0     0     0     0     0     0     0


                                                                                SCENARIO-ES-2      PAGE  1     12/20/74
```

```
                      1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

 43.   11121234          0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 44.   21122234          0     0     0     0     9    44    38     0     0     0     0     0     0     0     0     0
 45.   34123234          0     0     0     0    16    74    63     0     0     0     0     0     0     0     0     0
 46.   44125234          0     0     0     0   120   497   386     0     0     0     0     0     0     0     0     0
 47.   44126234          0     0     0     0   543  2173  1627     0     0     0     0     0     0     0     0     0
 48.   54127234          0     0     0     0   159   626   432     0     0     0     0     0     0     0     0     0
 49.   64129234          0     0     0     0    54   208   162     0     0     0     0     0     0     0     0     0

 50.   11121124          0     0     0     0     0     8    59   278   260   244   229   219   214   208   205   207
 51.   21122124          0     0     0     0     9    44   292  1117  1131  1146  1075  1029  1001   974   961   969
 52.   34123124          0     0     0     0     7    32   327  1304  1305  1310  1305  1249  1215  1183  1168  1177
 53.   44125124          0     0     0     0    15    64   464  1678  1567  1475  1383  1322  1287  1253  1236  1246
 54.   44126124          0     0     0     0    50   199   772  2330  2176  1966  1844  1764  1716  1671  1649  1661
 55.   54127124          0     0     0     0    20    90   424  1397  1218  1064   922   881   858   835   824   830
 56.   64128124          0     0     0     0    21    81   363  1211  1043   993   922   881   858   835   824   830

 85.   11221346          0     0     0     0     0     0     0     7    35    61    87   108   125   143   158   169
 86.   21222346          0     0     0     0     0     0     0    28   154   286   408   536   587   670   740   792
 87.   34223346          0     0     0     0     0     0     0    33   178   327   495   615   714   813   899   963
 88.   44225346          0     0     0     0     0     0     0    43   213   368   524   651   756   862   952  1019
 89.   44226346          0     0     0     0     0     0     0    59   296   491   699   868  1008  1149  1270  1359
 90.   54227346          0     0     0     0     0     0     0    35   166   265   349   434   503   574   635   679
 91.   64228346          0     0     0     0     0     0     0    31   142   245   349   434   503   574   635   679

TOTAL POPULATION      7115  8676  9321  9669  8625  8927  9240  9563  9898 10244 10603 10974 11358 11756 12167 12593
```

```
                      1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

   1.   11111656         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
   2.   21112656         0    60   251     0     0     0     0     0     0     0     0     0     0     0     0     0
   3.   34113656         0   104   307     0     0     0     0     0     0     0     0     0     0     0     0     0
   4.   44115656         0   156   503     0     0     0     0     0     0     0     0     0     0     0     0     0
   5.   44116656         0   260   810     0     0     0     0     0     0     0     0     0     0     0     0     0
   6.   54117656         0   164   531     0     0     0     0     0     0     0     0     0     0     0     0     0
   7.   64118656         0   121   391     0     0     0     0     0     0     0     0     0     0     0     0     0

   8.   11111655         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
   9.   21112655         0     0    75   278   209     0     0     0     0     0     0     0     0     0     0     0
  10.   34113655         0     0    92   347   255     0     0     0     0     0     0     0     0     0     0     0
  11.   44115655         0     0   150   626   419     0     0     0     0     0     0     0     0     0     0     0
  12.   44116655         0     0   243  1044   675     0     0     0     0     0     0     0     0     0     0     0
  13.   54117655         0     0   159   695   442     0     0     0     0     0     0     0     0     0     0     0
  14.   64118655         0     0   117   487   325     0     0     0     0     0     0     0     0     0     0     0

  15.   11111655         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  16.   21112655         0     0   112   417   314     0     0     0     0     0     0     0     0     0     0     0
  17.   34113655         0     0   138   521   383     0     0     0     0     0     0     0     0     0     0     0
  18.   44115655         0     0   226   939   628     0     0     0     0     0     0     0     0     0     0     0
  19.   44116655         0     0   364  1566  1013     0     0     0     0     0     0     0     0     0     0     0
  20.   54117655         0     0   238  1043   663     0     0     0     0     0     0     0     0     0     0     0
  21.   64118655         0     0   176   730   488     0     0     0     0     0     0     0     0     0     0     0

  22.   11111469         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  23.   21112469         0   545   398    77    58     0     0     0     0     0     0     0     0     0     0     0
  24.   34113469       924   936   486    96    71     0     0     0     0     0     0     0     0     0     0     0
  25.   44115469      1350  1405   796   174   116     0     0     0     0     0     0     0     0     0     0     0
  26.   44116469      2276  2342  1283   290   187     0     0     0     0     0     0     0     0     0     0     0
  27.   54117469      1493  1483   840   193   122     0     0     0     0     0     0     0     0     0     0     0
  28.   64118469      1066  1092   619   135    99     0     0     0     0     0     0     0     0     0     0     0

  29.   11121346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  30.   21122346         0     0     0     0    85   388   320     0     0     0     0     0     0     0     0     0
  31.   34123346         0     0     0     0    87   395   333     0     0     0     0     0     0     0     0     0
  32.   44125346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  33.   44126346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  34.   54127346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  35.   64128346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

  36.   11121346         0     0     0     0     0    79   124     0     0     0     0     0     0     0     0     0
  37.   21122346         0     0     0     0    89   405   335     0     0     0     0     0     0     0     0     0
  38.   34123346         0     0     0     0   125   567   477     0     0     0     0     0     0     0     0     0
  39.   44125346         0     0     0     0   252  1043   810     0     0     0     0     0     0     0     0     0
  40.   44126346         0     0     0     0    31   124    93     0     0     0     0     0     0     0     0     0
  41.   54127346         0     0     0     0   229   899   620     0     0     0     0     0     0     0     0     0
  42.   64128346         0     0     0     0   225   870   675     0     0     0     0     0     0     0     0     0


                                                                     SCENARIO-EW        PAGE  1      01/21/75
```

```
                        1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

  43.  11121234           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  44.  21122234           0     0     0     0     9    42    30     0     0     0     0     0     0     0     0     0
  45.  34123234           0     0     0     0    16    74    63     0     0     0     0     0     0     0     0     0
  46.  44125234           0     0     0     0   120   497   386     0     0     0     0     0     0     0     0     0
  47.  44126234           0     0     0     0   543  2173  1627     0     0     0     0     0     0     0     0     0
  48.  54127234           0     0     0     0   159   626   432     0     0     0     0     0     0     0     0     0
  49.  64128234           0     0     0     0    54   208   162     0     0     0     0     0     0     0     0     0

  50.  11121124           0     0     0     0     0     8    36   138   138   139   138   139   138   140   145   150
  51.  21122124           0     0     0     0     9    44   200   730   803   870   882   879   866   871   902   933
  52.  34123124           0     0     0     0     7    32   318  1287  1383  1478  1571  1571  1572  1597  1654  1712
  53.  44125124           0     0     0     0    15    64   464  1712  1732  1742  1760  1761  1768  1798  1860  1926
  54.  44126124           0     0     0     0    50   199   772  2390  2460  2396  2429  2461  2493  2538  2628  2718
  55.  54127124           0     0     0     0    20    80   424  1433  1385  1330  1272  1316  1362  1410  1460  1510
  56.  64128124           0     0     0     0    21    81   363  1242  1186  1229  1272  1316  1362  1410  1460  1510

 134.  11141122           0     0     0     0     0     0    22   136   137   136   137   136   138   140   145   150
 135.  21142122           0     0     0     0     0     0    71   318   344   369   367   368   373   361   374   387
 136.  34143122           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 137.  44145122           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 138.  44146122           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 139.  54147122           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 140.  64148122           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 176.  11321124           0     0     0     0     0     0     1    10    19    29    40    51    62    70    72    75
 177.  21322124           0     0     0     0     0    11    58    97   138   193   233   287   349   411   425   440
 178.  34323124           0     0     0     0     0     0     9    50   100   159   229   293   357   399   413   428
 179.  44325124           0     0     0     0     0     0     0     8    48   101   147   212   275   317   328   339
 180.  44326124           0     0     0     0     0     0     0     0    12    61   114   171   231   282   292   302
 181.  54327124           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 182.  64328124           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 TOTAL POPULATION      7115  8676  9321  9669  8625  8927  9240  9563  9898 10244 10603 10974 11358 11756 12167 12593




                                                                          SCENARIO-EW        PAGE  2     01/21/75
```

```
                                 1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

  1.   11111656                     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  2.   21112656                     0    60   251     0     0     0     0     0     0     0     0     0     0     0     0     0
  3.   34113656                     0   104   307     0     0     0     0     0     0     0     0     0     0     0     0     0
  4.   44115656                     0   156   503     0     0     0     0     0     0     0     0     0     0     0     0     0
  5.   44116656                     0   260   810     0     0     0     0     0     0     0     0     0     0     0     0     0
  6.   54117656                     0   164   531     0     0     0     0     0     0     0     0     0     0     0     0     0
  7.   64118656                     0   121   391     0     0     0     0     0     0     0     0     0     0     0     0     0

  8.   11111655                     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  9.   21112655                     0     0    75   278   209     0     0     0     0     0     0     0     0     0     0     0
 10.   34113655                     0     0    92   347   255     0     0     0     0     0     0     0     0     0     0     0
 11.   44115655                     0     0   150   626   419     0     0     0     0     0     0     0     0     0     0     0
 12.   44116655                     0     0   243  1044   675     0     0     0     0     0     0     0     0     0     0     0
 13.   54117655                     0     0   159   695   442     0     0     0     0     0     0     0     0     0     0     0
 14.   64118655                     0     0   117   487   325     0     0     0     0     0     0     0     0     0     0     0

 15.   11111655                     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 16.   21112655                     0     0   112   417   314     0     0     0     0     0     0     0     0     0     0     0
 17.   34113655                     0     0   138   521   383     0     0     0     0     0     0     0     0     0     0     0
 18.   44115655                     0     0   226   939   628     0     0     0     0     0     0     0     0     0     0     0
 19.   44116655                     0     0   364  1566  1013     0     0     0     0     0     0     0     0     0     0     0
 20.   54117655                     0     0   238  1043   663     0     0     0     0     0     0     0     0     0     0     0
 21.   64118655                     0     0   176   730   488     0     0     0     0     0     0     0     0     0     0     0

 22.   11111469                     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 23.   21112469                     0   545   398    77    58     0     0     0     0     0     0     0     0     0     0     0
 24.   34113469                   924   936   486    96    71     0     0     0     0     0     0     0     0     0     0     0
 25.   44115469                  1350  1405   796   174   116     0     0     0     0     0     0     0     0     0     0     0
 26.   44116469                  2276  2342  1283   290   187     0     0     0     0     0     0     0     0     0     0     0
 27.   54117469                  1493  1483   840   193   122     0     0     0     0     0     0     0     0     0     0     0
 28.   64118469                  1066  1392   619   135    90     0     0     0     0     0     0     0     0     0     0     0

 29.   11121346                     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 30.   21122346                     0     0     0     0    85   392   335     0     0     0     0     0     0     0     0     0
 31.   34123346                     0     0     0     0    87   395   333     0     0     0     0     0     0     0     0     0
 32.   44125346                     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 33.   44126346                     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 34.   54127346                     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 35.   64128346                     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 36.   11121346                     0     0     0     0     0    79   124     0     0     0     0     0     0     0     0     0
 37.   21122346                     0     0     0     0    87   410   350     0     0     0     0     0     0     0     0     0
 38.   34123346                     0     0     0     0   125   567   477     0     0     0     0     0     0     0     0     0
 39.   44125346                     0     0     0     0   252  1043   810     0     0     0     0     0     0     0     0     0
 40.   44126346                     0     0     0     0    31   124    93     0     0     0     0     0     0     0     0     0
 41.   54127346                     0     0     0     0   229   899   620     0     0     0     0     0     0     0     0     0
 42.   64128346                     0     0     0     0   225   870   900   699     0     0     0     0     0     0     0     0

                                                                                SCENARIO-F1          PAGE   1      01/21/75
```

```
                     1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

  43.   11121234        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  44.   21122234        0     0     0     0     9    44    38     0     0     0     0     0     0     0     0     0
  45.   34123234        0     0     0     0    16    74    63     0     0     0     0     0     0     0     0     0
  46.   44125234        0     0     0     0   120   497   386     0     0     0     0     0     0     0     0     0
  47.   44126234        0     0     0     0   543  2173  1627     0     0     0     0     0     0     0     0     0
  48.   54127234        0     0     0     0   159   626   432     0     0     0     0     0     0     0     0     0
  49.   64128234        0     0     0     0    54   208   216   167     0     0     0     0     0     0     0     0

  50.   11121124        0     0     0     0     0     8    36   107     0     0     0     0     0     0     0     0
  51.   21122124        0     0     0     0     9    44   165   430     0     0     0     0     0     0     0     0
  52.   34123124        0     0     0     0     7    32   327  1004     0     0     0     0     0     0     0     0
  53.   44125124        0     0     0     0    15    64   464  1291     0     0     0     0     0     0     0     0
  54.   44126124        0     0     0     0    50   199   772  1793     0     0     0     0     0     0     0     0
  55.   54127124        0     0     0     0    20    80   424  1075     0     0     0     0     0     0     0     0
  56.   64128124        0     0     0     0    21    81    84    65     0     0     0     0     0     0     0     0

 134.   11141122        0     0     0     0     0     0    23   143   148   153   158   164   170   176   182   188
 135.   21142122        0     0     0     0     0     0   127   458   141   214   281   353   421   468   510   528
 136.   34143122        0     0     0     0     0     0     0    33   163   245   342   428   511   569   620   642
 137.   44145122        0     0     0     0     0     0     0    43   195   276   362   453   541   603   656   679
 138.   44146122        0     0     0     0     0     0     0    59   309   552   826  1086  1260  1410  1460  1510
 139.   54147122        0     0     0     0     0     0     0    35   173   299   413   542   629   705   730   755
 140.   64148122        0     0     0     0     0     0     0    31   148   276   413   542   629   705   730   755

 155.   11231124        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 156.   21232124        0     0     0     0     0     0     0     0     6    35    66    99   135   164   170   176
 157.   34233124        0     0     0     0     0     0     0     0     7    40    81   121   164   199   206   214
 158.   44235124        0     0     0     0     0     0     0     0     8    46    85   128   173   211   218   226
 159.   44236124        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 160.   54237124        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 161.   64238124        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 197.   11631123        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 198.   21632123        0     0     0     0     0     0     0     0     6    35    66    99   135   172   204   211
 199.   31633123        0     0     0     0     0     0     0     0     7    40    81   121   164   209   248   256
 200.   44635123        0     0     0     0     0     0     0     0     8    46    85   128   173   222   262   271
 201.   44636123        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 202.   54637123        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 203.   64638123        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 218.   11121121        0     0     0     0     0     0     0    35   148   153   158   164   170   176   182   188
 219.   21122121        0     0     0     0     0     0     0   257  1125  1110  1001   883   762   666   612   634
 220.   34123121        0     0     0     0     0     0     0   300  1298  1269  1215  1072   926   808   744   770
 221.   44125121        0     0     0     0     0     0     0   387  1558  1429  1287  1135   981   856   788   815
 222.   44126121        0     0     0     0     0     0     0   537  2163  1904  1717  1546  1464  1410  1460  1510
 223.   54127121        0     0     0     0     0     0     0   322  1211  1030   858   773   732   705   730   755
 224.   64128121        0     0     0     0     0     0     0   279  1037   952   858   773   732   705   730   755


                                                                    SCENARIO-F1          PAGE  2      01/21/75
```

```
                       1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

225.   11221124           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
226.   21222124           0     0     0     0     0     0     0     0     3    17    33    49    67    86   102   105
227.   34223124           0     0     0     0     0     0     0     0     3    20    40    60    82   104   124   128
228.   44225124           0     0     0     0     0     0     0     0     4    23    42    64    86   111   131   135
229.   44226124           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
230.   54227124           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
231.   64228124           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

232.   11321469           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
233.   21322469           0     0     0     0     0     0     0     0     3    17    33    49    67    86   102   105
234.   34323469           0     0     0     0     0     0     0     0     3    20    40    60    82   104   124   128
235.   44325469           0     0     0     0     0     0     0     0     4    23    42    64    86   111   131   135
236.   44326469           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
237.   54327469           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
238.   64328469           0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

TOTAL POPULATION       7115  8676  9321  9669  8625  8927  9240  9563  9898 10244 10603 10974 11358 11756 12167 12593
```

```
                    1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985

 1.  11111656          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 2.  21112656          0   60  251    0    0    0    0    0    0    0    0    0    0    0    0    0
 3.  34113656          0  104  307    0    0    0    0    0    0    0    0    0    0    0    0    0
 4.  44115656          0  156  503    0    0    0    0    0    0    0    0    0    0    0    0    0
 5.  44116656          0  260  810    0    0    0    0    0    0    0    0    0    0    0    0    0
 6.  54117656          0  164  531    0    0    0    0    0    0    0    0    0    0    0    0    0
 7.  64118656          0  121  391    0    0    0    0    0    0    0    0    0    0    0    0    0

 8.  11111655          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 9.  21112655          0    0   75  278  209    0    0    0    0    0    0    0    0    0    0    0
10.  34113655          0    0   92  347  255    0    0    0    0    0    0    0    0    0    0    0
11.  44115655          0    0  150  626  419    0    0    0    0    0    0    0    0    0    0    0
12.  44116655          0    0  243 1044  675    0    0    0    0    0    0    0    0    0    0    0
13.  54117655          0    0  159  695  442    0    0    0    0    0    0    0    0    0    0    0
14.  64118655          0    0  117  487  325    0    0    0    0    0    0    0    0    0    0    0

15.  11111655          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
16.  21112655          0    0  112  417  314    0    0    0    0    0    0    0    0    0    0    0
17.  34113655          0    0  138  521  383    0    0    0    0    0    0    0    0    0    0    0
18.  44115655          0    0  226  939  628    0    0    0    0    0    0    0    0    0    0    0
19.  44116655          0    0  364 1566 1013    0    0    0    0    0    0    0    0    0    0    0
20.  54117655          0    0  238 1043  663    0    0    0    0    0    0    0    0    0    0    0
21.  64118655          0    0  176  730  488    0    0    0    0    0    0    0    0    0    0    0

22.  11111469          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
23.  21112469          0  545  398   77   58    0    0    0    0    0    0    0    0    0    0    0
24.  34113469        924  936  486   96   71    0    0    0    0    0    0    0    0    0    0    0
25.  44115469       1350 1405  796  174  116    0    0    0    0    0    0    0    0    0    0    0
26.  44116469       2276 2342 1283  290  187    0    0    0    0    0    0    0    0    0    0    0
27.  54117469       1493 1483  840  193  122    0    0    0    0    0    0    0    0    0    0    0
28.  64118469       1066 1092  619  135   90    0    0    0    0    0    0    0    0    0    0    0

29.  11121346          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
30.  21122346          0    0    0    0   85  294    0    0    0    0    0    0    0    0    0    0
31.  34123346          0    0    0    0   87  297    0    0    0    0    0    0    0    0    0    0
32.  44125346          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
33.  44126346          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
34.  54127346          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
35.  64128346          0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

36.  11121346          0    0    0    0    0   59    0    0    0    0    0    0    0    0    0    0
37.  21122346          0    0    0    0   89  307    0    0    0    0    0    0    0    0    0    0
38.  34123346          0    0    0    0  125  425    0    0    0    0    0    0    0    0    0    0
39.  44125346          0    0    0    0  252  783    0    0    0    0    0    0    0    0    0    0
40.  44126346          0    0    0    0   31   93    0    0    0    0    0    0    0    0    0    0
41.  54127346          0    0    0    0  229  674    0    0    0    0    0    0    0    0    0    0
42.  64128346          0    0    0    0  225  652    0    0    0    0    0    0    0    0    0    0


                                                           SCENARIO-I         PAGE  1      01/21/75
```

```
                   1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

  43.   11121234      0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  44.   21122234      0     0     0     0     9    33     0     0     0     0     0     0     0     0     0     0
  45.   34123234      0     0     0     0    16    56     0     0     0     0     0     0     0     0     0     0
  46.   44125234      0     0     0     0   120   373     0     0     0     0     0     0     0     0     0     0
  47.   44126234      0     0     0     0   543  1630     0     0     0     0     0     0     0     0     0     0
  48.   54127234      0     0     0     0   159   469     0     0     0     0     0     0     0     0     0     0
  49.   64128234      0     0     0     0    54   156     0     0     0     0     0     0     0     0     0     0

  50.   11121124      0     0     0     0     0    17    69     0     0     0     0     0     0     0     0     0
  51.   21122124      0     0     0     0     9   189   533     0     0     0     0     0     0     0     0     0
  52.   34123124      0     0     0     0     7   291   900     0     0     0     0     0     0     0     0     0
  53.   44125124      0     0     0     0    15   449  1247     0     0     0     0     0     0     0     0     0
  54.   44126124      0     0     0     0    50   773  1871     0     0     0     0     0     0     0     0     0
  55.   54127124      0     0     0     0    20   461  1108     0     0     0     0     0     0     0     0     0
  56.   64128124      0     0     0     0    21   350   900     0     0     0     0     0     0     0     0     0

  71.   11121121      0     0     0     0     0     0    23   143   148   153   158   164   170   176   182   188
  72.   21122121      0     0     0     0     0     0   165   730   755   770   742   768   794   822   851   881
  73.   34123121      0     0     0     0     0     0   270  1170  1150  1105  1058  1002   965   998  1034  1070
  74.   44125121      0     0     0     0     0     0   373  1505  1380  1244  1120  1061  1022  1058  1094  1133
  75.   44126121      0     0     0     0     0     0   560  2091  1916  1659  1494  1415  1362  1410  1460  1510
  76.   54127121      0     0     0     0     0     0   332  1253  1073   897   731   625   544   563   584   603
  77.   64128121      0     0     0     0     0     0   270  1071   845   706   604   493   408   422   438   452

 134.   11141122      0     0     0     0     0    11    69     0     0     0     0     0     0     0     0     0
 135.   21142122      0     0     0     0     0    66   228     0     0     0     0     0     0     0     0     0
 136.   34143122      0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 137.   44145122      0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 138.   44146122      0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 139.   54147122      0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 140.   64148122      0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 141.   11141121      0     0     0     0     0     0    23   143   148   153   158   164   170   176   182   188
 142.   21142121      0     0     0     0     0     0    88   415   530   662   742   768   794   822   851   881
 143.   34143121      0     0     0     0     0     0    30   167   333   532   742   862   965   998  1034  1070
 144.   44145121      0     0     0     0     0     0    41   215   400   599   787   912  1022  1058  1094  1133
 145.   44146121      0     0     0     0     0     0    62   298   556   798  1049  1217  1362  1410  1460  1510
 146.   54147121      0     0     0     0     0     0    36   179   311   432   540   690   817   845   876   905
 147.   64148121      0     0     0     0     0     0    30   170   340   522   667   822   953   986  1022  1056

 TOTAL POPULATION  7115  8676  9321  9669  8625  8927  9240  9563  9898 10244 10603 10974 11358 11756 12167 12593



                                                                        SCENARIO-I          PAGE   2      01/21/75
```

```
                  1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

 1.  11111656        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 2.  21112656        0    60   251     0     0     0     0     0     0     0     0     0     0     0     0     0
 3.  34113656        0   104   307     0     0     0     0     0     0     0     0     0     0     0     0     0
 4.  44115656        0   156   503     0     0     0     0     0     0     0     0     0     0     0     0     0
 5.  44116656        0   260   810     0     0     0     0     0     0     0     0     0     0     0     0     0
 6.  54117656        0   164   531     0     0     0     0     0     0     0     0     0     0     0     0     0
 7.  64118656        0   121   391     0     0     0     0     0     0     0     0     0     0     0     0     0

 8.  11111655        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 9.  21112655        0     0    75   278   209     0     0     0     0     0     0     0     0     0     0     0
10.  34113655        0     0    92   347   255     0     0     0     0     0     0     0     0     0     0     0
11.  44115655        0     0   150   626   419     0     0     0     0     0     0     0     0     0     0     0
12.  44116655        0     0   243  1044   675     0     0     0     0     0     0     0     0     0     0     0
13.  54117655        0     0   159   695   442     0     0     0     0     0     0     0     0     0     0     0
14.  64118655        0     0   117   487   325     0     0     0     0     0     0     0     0     0     0     0

15.  11111655        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
16.  21112655        0     0   112   417   314     0     0     0     0     0     0     0     0     0     0     0
17.  34113655        0     0   138   521   383     0     0     0     0     0     0     0     0     0     0     0
18.  44115655        0     0   226   939   628     0     0     0     0     0     0     0     0     0     0     0
19.  44116655        0     0   364  1566  1013     0     0     0     0     0     0     0     0     0     0     0
20.  54117655        0     0   238  1043   663     0     0     0     0     0     0     0     0     0     0     0
21.  64118655        0     0   176   730   488     0     0     0     0     0     0     0     0     0     0     0

22.  11111469        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
23.  21112469        0   545   398    77    58     0     0     0     0     0     0     0     0     0     0     0
24.  34113469      924   936   486    96    71     0     0     0     0     0     0     0     0     0     0     0
25.  44115469     1350  1405   796   174   116     0     0     0     0     0     0     0     0     0     0     0
26.  44116469     2276  2342  1283   290   187     0     0     0     0     0     0     0     0     0     0     0
27.  54117469     1493  1483   840   193   122     0     0     0     0     0     0     0     0     0     0     0
28.  64118469     1066  1092   619   135    90     0     0     0     0     0     0     0     0     0     0     0

29.  11121346        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
30.  21122346        0     0     0     0    85   392   335     0     0     0     0     0     0     0     0     0
31.  34123346        0     0     0     0    87   395   333     0     0     0     0     0     0     0     0     0
32.  44125346        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
33.  44126346        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
34.  54127346        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
35.  64128346        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

36.  11121346        0     0     0     0     0    79   124     0     0     0     0     0     0     0     0     0
37.  21122346        0     0     0     0    89   410   350     0     0     0     0     0     0     0     0     0
38.  34123346        0     0     0     0   125   567   477     0     0     0     0     0     0     0     0     0
39.  44125346        0     0     0     0   252  1043   810     0     0     0     0     0     0     0     0     0
40.  44126346        0     0     0     0    31   124    93     0     0     0     0     0     0     0     0     0
41.  54127346        0     0     0     0   229   699   620     0     0     0     0     0     0     0     0     0
42.  64128346        0     0     0     0   225   870   675     0     0     0     0     0     0     0     0     0


                                                                SCENARIO-J         PAGE  1      01/21/75
```

		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
43.	11121234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44.	21122234	0	0	0	0	9	44	38	0	0	0	0	0	0	0	0	0
45.	34123234	0	0	0	0	16	74	63	0	0	0	0	0	0	0	0	0
46.	44125234	0	0	0	0	120	497	386	0	0	0	0	0	0	0	0	0
47.	44126234	0	0	0	0	543	2173	1627	0	0	0	0	0	0	0	0	0
48.	54127234	0	0	0	0	159	626	432	0	0	0	0	0	0	0	0	0
49.	64128234	0	0	0	0	54	208	162	0	0	0	0	0	0	0	0	0
50.	11121124	0	0	0	0	0	8	36	107	0	0	0	0	0	0	0	0
51.	21122124	0	0	0	0	9	44	215	602	0	0	0	0	0	0	0	0
52.	34123124	0	0	0	0	7	32	327	1004	0	0	0	0	0	0	0	0
53.	44125124	0	0	0	0	15	64	464	1291	0	0	0	0	0	0	0	0
54.	44126124	0	0	0	0	50	199	772	1793	0	0	0	0	0	0	0	0
55.	54127124	0	0	0	0	20	80	424	1075	0	0	0	0	0	0	0	0
56.	64128124	0	0	0	0	21	81	363	932	0	0	0	0	0	0	0	0
71.	11121121	0	0	0	0	0	0	0	35	148	153	158	164	170	176	182	188
72.	21122121	0	0	0	0	0	0	0	185	819	841	797	768	794	822	851	881
73.	34123121	0	0	0	0	0	0	0	300	1298	1269	1215	1095	1037	998	1034	1070
74.	44125121	0	0	0	0	0	0	0	387	1558	1429	1287	1159	1098	1058	1094	1133
75.	44126121	0	0	0	0	0	0	0	537	2163	1904	1717	1546	1464	1410	1460	1510
76.	54127121	0	0	0	0	0	0	0	322	1211	1033	858	756	647	563	584	603
77.	64128121	0	0	0	0	0	0	0	279	1023	875	731	625	510	422	438	452
134.	11141122	0	0	0	0	0	0	23	107	0	0	0	0	0	0	0	0
135.	21142122	0	0	0	0	0	0	76	258	0	0	0	0	0	0	0	0
136.	34143122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
137.	44145122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
138.	44146122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.	54147122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140.	64148122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
141.	11141121	0	0	0	0	0	0	0	35	148	153	158	164	170	176	182	188
142.	21142121	0	0	0	0	0	0	0	109	466	591	686	768	794	822	851	881
143.	34143121	0	0	0	0	0	0	0	33	185	368	585	769	892	998	1034	1070
144.	44145121	0	0	0	0	0	0	0	43	222	414	620	814	945	1058	1094	1133
145.	44146121	0	0	0	0	0	0	0	59	309	552	826	1086	1260	1410	1460	1510
146.	54147121	0	0	0	0	0	0	0	35	173	299	413	559	715	845	876	905
147.	64148121	0	0	0	0	0	0	0	31	163	353	540	690	851	986	1022	1056
TOTAL	POPULATION	7115	8676	9321	9669	8625	8927	9240	9563	9898	10244	10603	10974	11358	11756	12167	12593

```
                    1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

  1.   11111656        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  2.   21112656        0    60   251     0     0     0     0     0     0     0     0     0     0     0     0     0
  3.   34113656        0   104   307     0     0     0     0     0     0     0     0     0     0     0     0     0
  4.   44115656        0   156   503     0     0     0     0     0     0     0     0     0     0     0     0     0
  5.   44116656        0   260   810     0     0     0     0     0     0     0     0     0     0     0     0     0
  6.   54117656        0   164   531     0     0     0     0     0     0     0     0     0     0     0     0     0
  7.   64118656        0   121   391     0     0     0     0     0     0     0     0     0     0     0     0     0

  8.   11111655        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  9.   21112655        0     0    75   278   209     0     0     0     0     0     0     0     0     0     0     0
 10.   34113655        0     0    92   347   255     0     0     0     0     0     0     0     0     0     0     0
 11.   44115655        0     0   150   626   419     0     0     0     0     0     0     0     0     0     0     0
 12.   44116655        0     0   243  1044   675     0     0     0     0     0     0     0     0     0     0     0
 13.   54117655        0     0   159   730   465     0     0     0     0     0     0     0     0     0     0     0
 14.   64118655        0     0   117   452   302     0     0     0     0     0     0     0     0     0     0     0

 15.   11111655        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 16.   21112655        0     0   112   417   314     0     0     0     0     0     0     0     0     0     0     0
 17.   34113655        0     0   138   521   383     0     0     0     0     0     0     0     0     0     0     0
 18.   44115655        0     0   226   939   628     0     0     0     0     0     0     0     0     0     0     0
 19.   44116655        0     0   364  1566  1013     0     0     0     0     0     0     0     0     0     0     0
 20.   54117655        0     0   238  1095   698     0     0     0     0     0     0     0     0     0     0     0
 21.   64118655        0     0   176   678   454     0     0     0     0     0     0     0     0     0     0     0

 22.   11111469        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 23.   21112469        0   545   398    77    58     0     0     0     0     0     0     0     0     0     0     0
 24.   34113469      924   937   486    96    71     0     0     0     0     0     0     0     0     0     0     0
 25.   44115469     1350  1405   796   174   116     0     0     0     0     0     0     0     0     0     0     0
 26.   44116469     2276  2342  1283   290   187     0     0     0     0     0     0     0     0     0     0     0
 27.   54117469     1493  1483   840   202   129     0     0     0     0     0     0     0     0     0     0     0
 28.   64118469     1066  1092   619   125    84     0     0     0     0     0     0     0     0     0     0     0

 29.   11121346        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 30.   21122346        0     0     0     0    85   431   396     0     0     0     0     0     0     0     0     0
 31.   34123346        0     0     0     0    87   429   384     0     0     0     0     0     0     0     0     0
 32.   44125346        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 33.   44126346        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 34.   54127346        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 35.   64128346        0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 36.   11121346        0     0     0     0     0    79   186     0     0     0     0     0     0     0     0     0
 37.   21122346        0     0     0     0    89   451   414     0     0     0     0     0     0     0     0     0
 38.   34123346        0     0     0     0   125   614   550     0     0     0     0     0     0     0     0     0
 39.   44125346        0     0     0     0   252  1102   900     0     0     0     0     0     0     0     0     0
 40.   44126346        0     0     0     0    31   116    79     0     0     0     0     0     0     0     0     0
 41.   54127346        0     0     0     0   241   849   543     0     0     0     0     0     0     0     0     0
 42.   64128346        0     0     0     0   210   870   623     0     0     0     0     0     0     0     0     0


                                                                     SCENARIO-JSV        PAGE  1     01/21/75
```

```
                          1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

  43.   11121234             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  44.   21122234             0     0     0     0     9    49    45     0     0     0     0     0     0     0     0     0
  45.   34123234             0     0     0     0    16    81    72     0     0     0     0     0     0     0     0     0
  46.   44125234             0     0     0     0   120   525   429     0     0     0     0     0     0     0     0     0
  47.   44126234             0     0     0     0   543  2018  1385     0     0     0     0     0     0     0     0     0
  48.   54127234             0     0     0     0   168   591   378     0     0     0     0     0     0     0     0     0
  49.   64128234             0     0     0     0    50   208   149     0     0     0     0     0     0     0     0     0

  50.   11121124             0     0     0     0     0     8    55   179     0     0     0     0     0     0     0     0
  51.   21122124             0     0     0     0     9    49   255   752     0     0     0     0     0     0     0     0
  52.   34123124             0     0     0     0     7    34   377  1219     0     0     0     0     0     0     0     0
  53.   44125124             0     0     0     0    15    67   517  1506     0     0     0     0     0     0     0     0
  54.   44126124             0     0     0     0    50   185   658  1434     0     0     0     0     0     0     0     0
  55.   54127124             0     0     0     0    21    75   371   788     0     0     0     0     0     0     0     0
  56.   64128124             0     0     0     0    19    81   335   788     0     0     0     0     0     0     0     0

  71.   11121121             0     0     0     0     0     0     0    59   296   358   424   438   454   470   486   503
  72.   21122121             0     0     0     0     0     0     0   232  1072  1142  1196  1206  1249  1292  1338  1384
  73.   34123121             0     0     0     0     0     0     0   365  1645  1666  1645  1546  1464  1410  1460  1510
  74.   44125121             0     0     0     0     0     0     0   451  1904  1825  1717  1546  1464  1410  1460  1510
  75.   44126121             0     0     0     0     0     0     0   430  1558  1190   858   708   671   646   668   692
  76.   54127121             0     0     0     0     0     0     0   235   691   475   286   188   161   140   145   150
  77.   64128121             0     0     0     0     0     0     0   235   853   656   487   416   340   282   291   301

 134.   11141122             0     0     0     0     0     0    34   179     0     0     0     0     0     0     0     0
 135.   21142122             0     0     0     0     0     0    90   322     0     0     0     0     0     0     0     0
 136.   34143122             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 137.   44145122             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 138.   44146122             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 139.   54147122             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 140.   64148122             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 141.   11141121             0     0     0     0     0     0     0    59   296   358   424   438   454   470   486   503
 142.   21142121             0     0     0     0     0     0     0   125   609   802  1029  1206  1249  1292  1338  1384
 143.   34143121             0     0     0     0     0     0     0    40   235   483   792  1086  1260  1410  1460  1510
 144.   44145121             0     0     0     0     0     0     0    50   272   530   826  1086  1260  1410  1460  1510
 145.   44146121             0     0     0     0     0     0     0    47   222   345   413   497   577   646   668   692
 146.   54147121             0     0     0     0     0     0     0    26    98   138   137   139   178   211   218   226
 147.   64148121             0     0     0     0     0     0     0    26   135   264   360   460   567   658   681   704

 TOTAL  POPULATION        7115  8676  9321  9669  8625  8927  9240  9563  9898 10244 10603 10974 11358 11756 12167 12593
```

```
                    1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

  1.  11111656         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  2.  21112656         0    60   251     0     0     0     0     0     0     0     0     0     0     0     0     0
  3.  34113656         0   104   307     0     0     0     0     0     0     0     0     0     0     0     0     0
  4.  44115656         0   156   503     0     0     0     0     0     0     0     0     0     0     0     0     0
  5.  44116656         0   260   810     0     0     0     0     0     0     0     0     0     0     0     0     0
  6.  54117656         0   164   531     0     0     0     0     0     0     0     0     0     0     0     0     0
  7.  64118656         0   121   391     0     0     0     0     0     0     0     0     0     0     0     0     0

  8.  11111655         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  9.  21112655         0     0    75   278   209     0     0     0     0     0     0     0     0     0     0     0
 10.  34113655         0     0    92   347   255     0     0     0     0     0     0     0     0     0     0     0
 11.  44115655         0     0   150   626   419     0     0     0     0     0     0     0     0     0     0     0
 12.  44116655         0     0   243  1044   675     0     0     0     0     0     0     0     0     0     0     0
 13.  54117655         0     0   159   695   442     0     0     0     0     0     0     0     0     0     0     0
 14.  64118655         0     0   117   487   325     0     0     0     0     0     0     0     0     0     0     0

 15.  11111655         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 16.  21112655         0     0   112   417   314     0     0     0     0     0     0     0     0     0     0     0
 17.  34113655         0     0   138   521   383     0     0     0     0     0     0     0     0     0     0     0
 18.  44115655         0     0   226   939   628     0     0     0     0     0     0     0     0     0     0     0
 19.  44116655         0     0   364  1566  1013     0     0     0     0     0     0     0     0     0     0     0
 20.  54117655         0     0   238  1043   663     0     0     0     0     0     0     0     0     0     0     0
 21.  64118655         0     0   176   730   488     0     0     0     0     0     0     0     0     0     0     0

 22.  11111469         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 23.  21112469         0   545   398    77    58     0     0     0     0     0     0     0     0     0     0     0
 24.  34113469       924   936   486    96    71     0     0     0     0     0     0     0     0     0     0     0
 25.  44115469      1350  1405   796   174   116     0     0     0     0     0     0     0     0     0     0     0
 26.  44116469      2276  2342  1283   290   187     0     0     0     0     0     0     0     0     0     0     0
 27.  54117469      1493  1483   840   193   122     0     0     0     0     0     0     0     0     0     0     0
 28.  64118469      1066  1092   619   135    99     0     0     0     0     0     0     0     0     0     0     0

 29.  11121346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 30.  21122346         0     0     0     0    85   392   335     0     0     0     0     0     0     0     0     0
 31.  34123346         0     0     0     0    87   395   333     0     0     0     0     0     0     0     0     0
 32.  44125346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 33.  44126346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 34.  54127346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 35.  64128346         0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 36.  11121346         0     0     0     0     0    79   124     0     0     0     0     0     0     0     0     0
 37.  21122346         0     0     0     0    89   410   350     0     0     0     0     0     0     0     0     0
 38.  34123346         0     0     0     0   125   567   477     0     0     0     0     0     0     0     0     0
 39.  44125346         0     0     0     0   252  1043   810     0     0     0     0     0     0     0     0     0
 40.  44126346         0     0     0     0    31   124    93     0     0     0     0     0     0     0     0     0
 41.  54127346         0     0     0     0   229   829   620     0     0     0     0     0     0     0     0     0
 42.  64128346         0     0     0     0   225   870   675     0     0     0     0     0     0     0     0     0


                                                                 SCENARIO-K           PAGE   1       01/21/75
```

```
                          1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

 43.   11121234              0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 44.   21122234              0     0     0     0     9    44    38     0     0     0     0     0     0     0     0     0
 45.   34123234              0     0     0     0    16    74    63     0     0     0     0     0     0     0     0     0
 46.   44125234              0     0     0     0   120   497   386     0     0     0     0     0     0     0     0     0
 47.   44126234              0     0     0     0   543  2173  1627     0     0     0     0     0     0     0     0     0
 48.   54127234              0     0     0     0   159   626   432     0     0     0     0     0     0     0     0     0
 49.   64128234              0     0     0     0    54   208   162     0     0     0     0     0     0     0     0     0

 50.   11121124              0     0     0     0     0     8    36   138   121    80     0     0     0     0     0     0
 51.   21122124              0     0     0     0     9    44   203   724   729   569     0     0     0     0     0     0
 52.   34123124              0     0     0     0     7    32   282  1103  1075   798     0     0     0     0     0     0
 53.   44125124              0     0     0     0    15    64   423  1505  1380   968     0     0     0     0     0     0
 54.   44126124              0     0     0     0    50   199   710  2121  2009  1290     0     0     0     0     0     0
 55.   54127124              0     0     0     0    20    80   369  1189  1024   648     0     0     0     0     0     0
 56.   64128124              0     0     0     0    21    81   318  1030   877   599     0     0     0     0     0     0

 71.   11121121              0     0     0     0     0     0     0     0     0    22    88    68    51    35    36    37
 72.   21122121              0     0     0     0     0     0     0     0     0   161   630   499   357   246   255   264
 73.   34123121              0     0     0     0     0     0     0     0     0   224   945   792   627   499   517   535
 74.   44125121              0     0     0     0     0     0     0     0     0   276  1097   937   766   634   656   679
 75.   44126121              0     0     0     0     0     0     0     0     0   337  1303  1020   885   705   730   755
 76.   54127121              0     0     0     0     0     0     0     0     0   166   620   559   442   352   365   377
 77.   64128121              0     0     0     0     0     0     0     0     0   153   620   559   442   352   365   377

134.   11141122              0     0     0     0     0     0    11    72    57     0     0     0     0     0     0     0
135.   21142122              0     0     0     0     0     0    38   174   205   172     0     0     0     0     0     0
136.   34143122              0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
137.   44145122              0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
138.   44146122              0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
139.   54147122              0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
140.   64148122              0     0     0     0     0     0     0     0     0     0     0     0     0     0     C     0

141.   11141121              0     0     0     0     0     0    11    72    98   168   176   190   198   211   218   226
142.   21142121              0     0     0     0     0     0    38   174   205   297   537   633   734   822   851   881
143.   34143121              0     0     0     0     0     0    30   150   241   348   472   582   699   798   827   856
144.   44145121              0     0     0     0     0     0    41   193   289   391   500   616   740   846   875   906
145.   44146121              0     0     0     0     0     0    31   149   309   552   826  1086  1294  1551  1606  1661
146.   54147121              0     0     0     0     0     0    36   161   242   382   524   625   783   916   949   981
147.   64148121              0     0     0     0     0     0    30   139   207   353   524   625   783   916   949   981

148.   11131121              0     0     0     0     0     0     0     3    18    34    51    69    89   105   109   113
149.   21132121              0     0     0     0     0     0    12    71   144   232   315   403   496   575   595   616
150.   34133121              0     0     0     0     0     0    15    83   166   266   382   489   603   698   723   749
151.   44135121              0     0     0     0     0     0     0    21   111   207   310   419   536   634   656   679
152.   44136121              0     0     0     0     0     0    31   119   154   276   413   526   544   564   584   604
153.   54137121              0     0     0     0     0     0    18    82   117   132   127   131   136   140   146   150
154.   64138121              0     0     0     0     0     0    15    71   100   122   127   131   136   140   146   150

TOTAL POPULATION          7115  8676  9321  9669  8625  8927  92[illegible]  9563  9898 10244 10603 10974 11358 11756 12167 12593


                                                                   SCENARIO-K          PAGE  2      01/21/75
```

```
                         1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981  1982  1983  1984  1985

  1.   11111656             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  2.   21112656             0    60   251     0     0     0     0     0     0     0     0     0     0     0     0     0
  3.   34113656             0   104   307     0     0     0     0     0     0     0     0     0     0     0     0     0
  4.   44115656             0   156   503     0     0     0     0     0     0     0     0     0     0     0     0     0
  5.   44116656             0   260   810     0     0     0     0     0     0     0     0     0     0     0     0     0
  6.   54117656             0   164   531     0     0     0     0     0     0     0     0     0     0     0     0     0
  7.   64118656             0   121   391     0     0     0     0     0     0     0     0     0     0     0     0     0

  8.   11111655             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
  9.   21112655             0     0    75   278   209     0     0     0     0     0     0     0     0     0     0     0
 10.   34113655             0     0    92   347   255     0     0     0     0     0     0     0     0     0     0     0
 11.   44115655             0     0   150   626   419     0     0     0     0     0     0     0     0     0     0     0
 12.   44116655             0     0   243  1044   675     0     0     0     0     0     0     0     0     0     0     0
 13.   54117655             0     0   159   730   465     0     0     0     0     0     0     0     0     0     0     0
 14.   64118655             0     0   117   452   302     0     0     0     0     0     0     0     0     0     0     0

 15.   11111655             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 16.   21112655             0     0   112   417   314     0     0     0     0     0     0     0     0     0     0     0
 17.   34113655             0     0   138   521   383     0     0     0     0     0     0     0     0     0     0     0
 18.   44115655             0     0   226   939   628     0     0     0     0     0     0     0     0     0     0     0
 19.   44116655             0     0   364  1566  1013     0     0     0     0     0     0     0     0     0     0     0
 20.   54117655             0     0   238  1095   698     0     0     0     0     0     0     0     0     0     0     0
 21.   64118655             0     0   176   678   454     0     0     0     0     0     0     0     0     0     0     0

 22.   11111469             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 23.   21112469             0   545   398    77    58     0     0     0     0     0     0     0     0     0     0     0
 24.   34113469           924   937   486    96    71     0     0     0     0     0     0     0     0     0     0     0
 25.   44115469          1350  1405   796   174   116     0     0     0     0     0     0     0     0     0     0     0
 26.   44116469          2276  2342  1283   290   187     0     0     0     0     0     0     0     0     0     0     0
 27.   54117469          1493  1483   840   202   129     0     0     0     0     0     0     0     0     0     0     0
 28.   64118469          1066  1092   619   125    84     0     0     0     0     0     0     0     0     0     0     0

 29.   11121346             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 30.   21122346             0     0     0     0    85   431   396     0     0     0     0     0     0     0     0     0
 31.   34123346             0     0     0     0    87   429   384     0     0     0     0     0     0     0     0     0
 32.   44125346             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 33.   44126346             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 34.   54127346             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
 35.   64128346             0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0

 36.   11121346             0     0     0     0     0    79   186     0     0     0     0     0     0     0     0     0
 37.   21122346             0     0     0     0    89   451   414     0     0     0     0     0     0     0     0     0
 38.   34123346             0     0     0     0   125   614   550     0     0     0     0     0     0     0     0     0
 39.   44125346             0     0     0     0   252  1102   900     0     0     0     0     0     0     0     0     0
 40.   44126346             0     0     0     0    31   116    79     0     0     0     0     0     0     0     0     0
 41.   54127346             0     0     0     0   241   849   543     0     0     0     0     0     0     0     0     0
 42.   64128346             0     0     0     0   210   870   623     0     0     0     0     0     0     0     0     0


                                                                  SCENARIO-KSV        PAGE  1      01/21/75
```

		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
43.	11121234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44.	21122234	0	0	0	0	9	49	45	0	0	0	0	0	0	0	0	0
45.	34123234	0	0	0	0	16	81	72	0	0	0	0	0	0	0	0	0
46.	44125234	0	0	0	0	120	525	429	0	0	0	0	0	0	0	0	0
47.	44126234	0	0	0	0	543	2018	1385	0	0	0	0	0	0	0	0	0
48.	54127234	0	0	0	0	168	591	378	0	0	0	0	0	0	0	0	0
49.	64128234	0	0	0	0	53	208	149	0	0	0	0	0	0	0	0	0
50.	11121124	0	0	0	0	0	8	55	230	243	187	0	0	0	0	0	0
51.	21122124	0	0	0	0	9	49	240	906	954	773	0	0	0	0	0	0
52.	34123124	0	0	0	0	7	34	325	1340	1363	1048	0	0	0	0	0	0
53.	44125124	0	0	0	0	15	67	471	1756	1687	1236	0	0	0	0	0	0
54.	44126124	0	0	0	0	50	185	605	1696	1447	806	0	0	0	0	0	0
55.	54127124	0	0	0	0	21	75	323	871	584	299	0	0	0	0	0	0
56.	64128124	0	0	0	0	19	81	293	871	731	449	0	0	0	0	0	0
71.	11121121	0	0	0	0	0	0	0	0	0	53	237	181	138	94	97	100
72.	21122121	0	0	0	0	0	0	0	0	0	218	946	784	562	387	401	415
73.	34123121	0	0	0	0	0	0	0	0	0	295	1279	1119	885	705	730	755
74.	44125121	0	0	0	0	0	0	0	0	0	353	1462	1250	1021	846	876	906
75.	44126121	0	0	0	0	0	0	0	0	0	211	651	467	405	323	334	346
76.	54127121	0	0	0	0	0	0	0	0	0	76	206	139	110	88	91	94
77.	64128121	0	0	0	0	0	0	0	0	0	115	413	372	295	235	243	251
134.	11141122	0	0	0	0	0	0	17	120	115	0	0	0	0	0	0	0
135.	21142122	0	0	0	0	0	0	45	218	269	233	0	0	0	0	0	0
136.	34143122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
137.	44145122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
138.	44146122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.	54147122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140.	64148122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
141.	11141121	0	0	0	0	0	0	17	120	197	393	472	508	531	564	583	603
142.	21142121	0	0	0	0	0	0	45	218	269	403	806	995	1155	1292	1338	1384
143.	34143121	0	0	0	0	0	0	34	182	305	456	639	822	987	1128	1168	1208
144.	44145121	0	0	0	0	0	0	46	225	353	500	667	822	987	1128	1168	1208
145.	44146121	0	0	0	0	0	0	26	119	222	345	413	497	593	710	735	761
146.	54147121	0	0	0	0	0	0	32	118	138	176	174	155	195	228	236	245
147.	64148121	0	0	0	0	0	0	27	118	173	264	349	416	522	611	632	653
148.	11131121	0	0	0	0	0	0	0	5	37	80	137	186	238	282	291	301
149.	21132121	0	0	0	0	0	0	15	89	189	316	473	633	780	904	936	969
150.	34133121	0	0	0	0	0	0	17	101	211	349	518	691	851	987	1022	1057
151.	44135121	0	0	0	0	0	0	0	25	136	265	413	559	715	846	876	906
152.	44136121	0	0	0	0	0	0	26	95	111	172	206	241	249	258	267	276
153.	54137121	0	0	0	0	0	0	16	60	67	61	42	32	34	35	36	37
154.	64138121	0	0	0	0	0	0	13	63	54	92	84	87	90	94	97	103
TOTAL POPULATION		7115	8676	9321	9669	8625	8927	9240	9563	9898	10244	10603	10974	11358	11756	12167	12593

APPENDIX G

Methodology for Summarizing Yearly Operating Costs

The purpose of the calculations summarizing yearly operating costs is to evaluate the likely impact of various policy options, such as alternative emissions standards, on the U.S. driving public. The estimate proceeds from a time-phased scenario of cars to be made as described in Appendix F. It is always a matter of judgment on the part of the investigator preparing the scenario as to how he sees the U.S. automobile industry responding to a certain combination of hypothetical conditions. The scenario can be checked in various ways for reasonableness, but never completely verified. So the final estimates, no matter how precisely calculated, can be of no better quality than the scenario input.

The scenario requests that certain car sizes and configurations be made in specified volume (or discontinued) year by year from 1970 to 1985. Each vehicle configuration has associated with it a fuel consumption rate (Appendix I), yearly maintenance cost (Appendix J), and list price (Appendix K).

A complete scenario consists of three subsections: (a) cars to be produced by domestic manufacturers from 1970 to 1985 (numbered 1 to 238), (b) cars to be imported from overseas from 1970 to 1985 (numbered 701 to 705), and (c) cars already in use in the U.S. prior to 1970 (all combined into class 999). Cars in categories (a) and (b) were treated on a car-by-car basis as will be described below. Category (c) cars, those existing prior to 1970, were treated as a single typical vehicle whose residual population remaining was attenuated so as to have a vehicle-in-use population in reasonable accord with vehicle registration data. The resultant attention factors (aging factors) and vehicle-in-use population are listed in Table G1. Since the same pattern of pre-1970 cars and vehicles-in-use was obtained in every scenario run, it would be expected that the final incremental

TABLE G1

Total Vehicles-in-use and Pre-1970 Cars Remaining as Used in All Cost Summary Calculations

Year	Vehicles-in-use Aging Factor for Pre-1970 (999) Population	Total Pre-1970 Cars Remaining (Millions)	Total of all Vehicles-in-use (Millions)
1969	1.000	74.366*	74.366
1970	.918	68.3	76.6
1971	.767	57.0	75.5
1972	.685	50.9	80.2
1973	.589	4[illegible]8	84.1
1974	.479	3[illegible]6	85.4
1975	.384	28.6	87.6
1976	.315	23.4	91.1
1977	.233	17.3	92.7
1978	.151	11.2	93.4
1979	.082	6.1	94.0
1980	.055	4.1	97.0
1981	.027	2.0	99.5
1982	-0-	-0-	101.8
1983	-0-	-0-	106.0
1984	-0-	-0-	110.1
1985	-0-	-0-	113.9

*To find the remaining 999 cars in any year, multiply the aging factor for that year from Column 2 by this number.

cost between scenarios would be relatively insensitive to small absolute errors in the detail with which the pre-1970 cars were treated.

Each vehicle which may be used in any scenario, including imported cars (700's) and pre-1970 cars, has an initial value and a set of aging or attenuation factors for the following parameters: vehicles-in-use, miles per year driven, fuel consumed per mile, maintenance per year, HC emissions per mile, CO emissions per mile, and NO_x emissions per mile. The values used for three typical cars (No's 53, 703, and 999) are shown in Table G2. The initial values for vehicles-in-use is 0.0, which indicates it must be obtained from the scenario. All aging factors are the same for all vehicles, except the 999 vehicles-in-use aging factor discussed above. All new cars drive 16,000 miles per year, burn the amount of fuel per mile indicated in Appendix I, and have a maintenance cost per mile determined by dividing the maintenance per year from Appendix J by the 16,000 miles driven in the first year. Initial emissions values are taken as the grams per mile value for the standard to which the engine would be certified.

As a preliminary to the cost calculation, several parameters are calculated on a yearly basis: the total vehicles-in-use; total miles driven and average miles driven per car; total and average number of gallons of fuel consumed; total average per car and average per mile cost of maintenance; and total and average grams per mile of HC, CO and NO_x emissions. These calculations are all carried forward in an analogous fashion. For a given year and car, for example, the contribution of new cars of class 50 to the vehicles-in-use in 1980 is looked up. To this is added the number of one-year old cars of class 50 existant in 1980 by multiplying the number of new class 50 cars made in the prior year by the second year's aging factor, and proceeding through class 50 cars of all ages in 1980. The total tally is stored, and the process is continued until all car classes and years

TABLE G2

Typical Aging Factor

```
         VEHICLE SERIAL #   53.
VEHICLES-IN-USE      0.0
  1.000  0.997  0.987  0.968  0.934  0.871  0.769  0.644  0.515  0.382  0.283  0.208  0.151  0.110  0.080  0.0
MILES/YEAR         16000.000000
  1.000  0.900  0.780  0.680  0.590  0.540  0.520  0.500  0.450  0.430  0.360  0.300  0.270  0.270  0.270  0.0
FUEL                   0.076300
  1.000  1.010  1.020  1.030  1.040  1.050  1.050  1.050  1.050  1.050  1.050  1.050  1.050  1.050  1.050  0.0
MAINTENANCE            0.003300
  1.000  1.000  1.000  1.000  1.050  1.150  1.200  1.200  1.200  1.200  1.200  1.200  1.200  1.200  1.200  0.0
HC-EMISSIONS           0.400000
  0.830  0.930  0.980  1.000  1.020  1.020  1.030  1.040  1.050  1.060  1.070  1.080  1.090  1.100  1.100  0.0
CO-EMISSION            9.000000
  0.780  0.900  0.970  1.000  1.020  1.030  1.040  1.050  1.060  1.070  1.080  1.080  1.080  1.080  1.090  0.0
NOX-EMISSION           2.000000
  0.900  0.950  0.980  1.000  1.010  1.020  1.030  1.040  1.040  1.050  1.060  1.060  1.070  1.070  1.070  0.0


         VEHICLE SERIAL #  703.
VEHICLES-IN-USE      0.0
  1.000  0.997  0.987  0.968  0.934  0.871  0.769  0.644  0.515  0.382  0.283  0.208  0.151  0.110  0.080  0.0
MILES/YEAR         16000.000000
  1.000  0.900  0.780  0.680  0.590  0.540  0.520  0.500  0.450  0.430  0.360  0.300  0.270  0.270  0.270  0.0
FUEL                   0.059200
  1.000  1.010  1.020  1.030  1.040  1.050  1.050  1.050  1.050  1.050  1.050  1.050  1.050  1.050  1.050  0.0
MAINTENANCE            0.002800
  1.000  1.000  1.000  1.000  1.050  1.150  1.200  1.200  1.200  1.200  1.200  1.200  1.200  1.200  1.200  0.0
HC-EMISSIONS           0.400000
  0.830  0.930  0.980  1.000  1.020  1.020  1.030  1.040  1.050  1.060  1.070  1.080  1.090  1.100  1.100  0.0
CO-EMISSION            3.400000
  0.780  0.900  0.970  1.000  1.020  1.030  1.040  1.050  1.060  1.070  1.080  1.080  1.080  1.080  1.090  0.0
NOX-EMISSION           6.000000
  0.900  0.950  0.980  1.000  1.010  1.020  1.030  1.040  1.040  1.050  1.060  1.060  1.070  1.070  1.070  0.0


         VEHICLE SERIAL #  999.
VEHICLES-IN-USE      0.0
  0.918  0.767  0.685  0.589  0.479  0.384  0.315  0.233  0.151  0.082  0.055  0.027  0.0    0.0    0.0    0.0
MILES/YEAR         16000.000000
  0.590  0.540  0.520  0.500  0.450  0.430  0.360  0.300  0.270  0.270  0.270  0.270  0.270  0.270  0.270  0.0
FUEL                   0.075800
  1.040  1.050  1.050  1.050  1.050  1.050  1.050  1.050  1.050  1.050  1.050  1.050  1.050  1.050  1.050  0.0
MAINTENANCE            0.002000
  1.050  1.150  1.200  1.200  1.200  1.200  1.200  1.200  1.200  1.200  1.200  1.200  1.200  1.200  1.200  0.0
HC-EMISSIONS           3.900000
  1.020  1.020  1.030  1.040  1.050  1.060  1.070  1.080  1.090  1.100  1.100  1.100  1.100  1.100  1.100  0.0
CO-EMISSION           33.000000
  1.020  1.030  1.040  1.050  1.060  1.070  1.080  1.080  1.080  1.080  1.090  1.090  1.090  1.090  1.090  0.0
NOX-EMISSION           6.000000
  1.010  1.020  1.030  1.040  1.040  1.040  1.050  1.060  1.060  1.070  1.070  1.070  1.070  1.070  1.070  0.0
```

have been considered. The yearly columns are then totalled and averaged appropriately. All of the intermediate matrices cited above are retained and printed with the output to provide complete data traceability.

The cost summary report lists, by year from 1970 to 1985, the total cost of fuel, maintenance, and sticker price, and the average per car of these same qualities. It also presents the incremental difference in each of these quantities over the baseline scenario (Scenario A). Fuel cost is obtained by multiplying miles driven times gas mileage (gpm) times cost of fuel* for each age of car in a given class and summing over all cars in use in that year. Maintenance is obtained by calculating miles driven times maintenance cost per mile for each age of car in a given class and summing over all cars in use in that year. Sticker price is simply the sticker list price total for new cars sold in a particular year. Provision was made for adding in the investment cost from the investment program, but this feature was not used.

All cost calculations use constant 1974 dollars. In most cases the data were gathered in 1974, so no conversion was necessary. Where data obtained in other years were used, they were converted to 1974 dollars using the consumer price index for the appropriate year. This constant dollar basis is important because of the uncertainties associated with current inflation rates.

Since all calculations are in constant 1974 dollars, the appropriate interest rate for amortizing capital costs or discounting past or future expenditures is one from which inflation has been removed. Although current interest rates may be in two figures for borrowing purposes, most of this is in fact a compensation for the inflation rate. The real interest rate, or an appropriate discount rate for project evaluation, would be on the order of 3% to 4%. We have used 4% to discount all fuel, maintenance, and sticker costs back to 1970. These values (marked p.v.) all appear on the cost summary report.

---

*Cars use either leaded or unleaded regular gasoline or diesel fuel as appropriate.

A complete set of cost summary reports for all scenarios considered in the present study are included here as Appendix N.

APPENDIX H

Automotive Fuel Cost and Availability

(Written by William A. Johnson and James Kittrell)

In 1972, world oil demand was about 53 million barrels per day (of which the free world accounts for 85% and the U.S. alone for 30%). World demand has been increasing at between 7% and 8% over the last 10 years,[1] with recent annual production increments of about 3 million barrels per day--about 1.5 times projected Alaskan production from the North Slope (the largest field ever found in the U.S. and the fifth largest in the world). By 1980, unconstrained world oil demand could reach 90 million barrels per day requiring annual increments on the order of 5 million barrels per day to satisfy projected demand. Middle East production alone could increase by 22 million barrels per day, accounting for 70% of the total free world increase between 1972 and 1980. Even with these potential unconstrained production increases, the resource base seems adequate in the short term. By 1985, however, the reserve-to-production ratio in the Middle East could fall from the present level of about 50 years to 20 years. This could signal alarm to the producing countries and cause them to impose production controls even though technically the reserve-to-production ratio could fall as low as 10 years, as is the case now in the U.S.

Any assessment of when reserves will become limiting is speculative and depends upon estimates of: the rate at which new oil in place is discovered (or reported); the rate at which recovery factors improve (worldwide, only about 30% of the discovered oil in place is now classed as recoverable); and the rate at which the oil demand grows. Analysis is further complicated by the fact that published reserve figures are not reported on a consistant basis, particularly outside North America. Our best estimate is that the world will become supply-limited in the early 1990's. Production will not immediately decline when this point is reached; decline may not set in until 15 or 20 years later.

The production of crude oil from any given country will depend upon (1) the total volume of oil reserves; (2) proportion of oil reserves which may be economically recovered; (3) maximum production rates that can be achieved without reservoir depletion; (4) investment in productive capacity already implemented; and (5) political constraints on production rates. Assuming that all non-OPEC countries produce at the maximum productive capacity and that a constrained oil demand rate of 3% to 4% per year exists, it is likely that total world supply capability will exceed demand through 1985. Furthermore, four OPEC countries already generate revenues in excess of their domestic expenditure level before the recent oil price rise (Saudia Arabia, Kuwait, Abu Dhabi and Libya). An analysis of world production capacit indicates that a surplus revenue country cartel could control world production to maintain prices at the present level without internal economic hardships.

Hence, it is concluded that world energy prices in constant dollars will probably remain at current levels through 1985, with short-term fluctuations due to supply/demand imbalances. These levels will reduce the previous high growth rates in petroleum consumption and stimulate the supply of petroleum and alternate energy sources.

U.S. Petroleum Supply/Demand

Projection of U.S. petroleum supply/demand is subject to many of the uncertainties evident in world supply/demand projections. Pre-embargo forecasts of domestic crude oil and natural gas production in 1985 were around 10 million barrels per day[2], including Alaskan production and synthetic crudes. Recent projections[3] indicate that 1985 domestic production could reach 15 million barrels per day, with sustained high crude prices, accelerated offshore federal leasing programs, and opening the offshore U.S. East Coast and offshore Alaskan areas to exploration. Clearly, domestic U.S. production capability will be dependent upon governmental policy decisions.

Petroleum demand (including imported products, crude and natural gas liquids) has been about 16 million barrels per day.[2] Pre-embargo growth forecasts were about 4% per year;[4] post-embargo growth forecasts project a flat growth through 1975 and a 2% growth rate thereafter,[3] although predictions of price elasticity and economic growth are quite important to this projection. Furthermore, projections of the growth rate of specific products, such as residual fuel oil, vary from very high (to supplant natural gas) to negative (due to conservation and alternative energy sources).

Even considering these variables, it is clear that the U.S. will be dependent upon imported Middle East crude oil through 1985. A recent survey of petroleum companies indicated that 20% to 50% of the U.S. crude run will be imported in 1985, consistent with the above projections. Hence, a primary conclusion of these projections can be drawn. It is unrealistic to insulate U.S. energy prices from world parity. Further increases in domestic crude price will constrain demand and increase supply to where the U.S. should be able to essentially maintain its current level of dependency on foreign supply sources through 1985.

Supply Economics - Leaded Regular Gasoline

To assist the fuel supply portion of this study, a comprehensive seven-page questionnaire was prepared to solicit comments on general background as well as specific detailed information relative to the economics of fuel supply. This questionnaire was sent to nine oil companies representing a cross-section of the industry in regard to size (both majors and independents participated) and to cover all geographic regions in the U.S. Industry cooperation was good and only one recipient did not respond. Several companies provided considerable useful information.

There are essentially five elements comprising the cost of supplying automotive fuel to the consumer at the service station pump. These include: (1) crude oil cost, (2) refining margin, (3) distribution (primary, secondary and terminal costs) (4) service station margin, and (5) federal, state and local taxes. By adjustment of recently published statistics[5] using questionnaire results, we have made estimates for each of these various elements in constant 1974 dollars. These estimates are:

	Cents Per Gallon
Crude Oil	24.0
Refining	5.0
Distribution	5.0
Service Station	9.0
Taxes	12.0
TOTAL	55.0

It can be seen that the most important element in establishing the cost of leaded regular gasoline at the pump is crude oil. This is also the element about which the greatest uncertainty exists as discussed in the previous section. The 24.0 cents per gallon is equivalent to a $10.08/barrel average crude cost.

We estimate the refining cost element for leaded regular gasoline compared to crude oil will be 5.0 cents per gallon. The historical margin between regular gasoline and crude oil has ranged between 2.0-3.0 cents per gallon. However, refinery construction costs have increased dramatically during the past few years. Since the volumetric yield of marketable products from a refinery represents about 95% of the raw material input, when the absolute value of crude oil rises, the required margin between a composite of finished products over crude oil must increase further.

Although growth in refinery construction costs has been greater than inflation in general in recent years, we do not expect this trend to continue over the next decade. We anticipate increases in productivity in refinery construction, improved design technology, and increased economies of scale will all offset somewhat the rise in basic construction costs. Therefore, we have assumed that the refining cost of 5.0 cents per gallon will be maintained in constant 1974 dollars throughout the study period.

Our estimate of distribution costs (which is also 5.0 cents per gallon) covers primary distribution from the refinery to terminal, terminating expenses, and transportation from the terminal to the service station. We expect the first two items comprising the overall distribution cost to slightly decrease over time in constant 1974 dollars. A continuing higher percentage of primary distribution products are moved by pipeline (for cost and environmental reasons) which is less susceptible to inflation than other transportation methods. It is usually possible to increase product throughputs through existing terminals without major construction programs. The delivery of the product from the terminal to the service station (usually by transport truck) will experience increased labor and fuel costs, the combination of which could slightly increase in constant 1974 dollars, thus cancelling out potential savings of the other two items.

Service station costs will be influenced by land values, service station construction costs, and labor rate and productivity of station attendants. Historically, the independent gasoline marketer was able to operate with a service station margin of about 6.0 cents per gallon while the typical major service station required an additional 1.0-2.0 cents per gallon. These margins have risen to about 9.0

cents per gallon in the last few months which is probably a more realistic level for the long term. More sophisticated planning techniques by the oil companies will review carefully the desirability of building labor intensive, full-service stations. Improved labor utilization will probably enable marketers to maintain this 9.0 cents per gallon margin in constant dollars.

It is difficult to predict the political environment which will control taxes on automotive fuels. Gasoline taxes are generally considered to be regressive in nature and at current national sales volumes, a 1.0 cents per gallon increase in tax represents approximately 1 billion dollars a year in revenue. We feel no major changes in present taxing levels will take place, however, increased pressures for governmental revenues will probably keep pace with inflation.

Supply Economics - Other Conventional Fuels

We have tabulated our estimate, based in part on survey information, of differential pump prices in constant dollars for the alternative conventional fuels considered in this study.

Product	Differential Pump Price Vs. Leaded Regular Gasoline
Leaded Premium Gasoline	+4.0
Unleaded Regular Gasoline (min 91/83 RON/MON)	+2.0
Unleaded Premium Gasoline (min 95/87 RON/MON)	+5.0
Diesel Fuel	-2.0/-1.0*
Fuel Suitable for TCCS (Texaco Controlled-Combustion Systems)	-3.0

* -2.0 until 1980, -1.0 thereafter

It should be noted that we expect constant differentials to prevail through 1985 with the exception of diesel fuel.

Leaded Premium Gasoline

Historically, this product has been priced 3.0-4.0 cents per gallon greater than leaded regular gasoline although manufacturing costs are only about 1.0-2.0 cents per gallon higher. Distribution and marketing costs for supplying two grades of gasoline have been allocated primarily to the premium grade. It is recognized that premium gasoline has been a "higher profit" product for the oil companies.

Premium gasoline as a percent of total U.S. sales peaked about 1970 at around 45% of total gasoline. Since then, a combination of factors such as lower compression ratio engines in late model cars and a growing awareness among the motorists that it is not necessary or desirable to "overbuy" octane have reduced the percentage to around 35%. As premium gasoline volume declines, the manufacturing cost to supply this grade decreases but the expense of maintaining separate storage and distribution facilities for this grade must be allocated over a smaller base. Thus, we do not believe that the oil companies will reduce the present attractive margins on premium gasoline as this product is gradually phased from the market place.

Unleaded Regular Gasoline

Many studies have been made in the past several years concerning supply economics for unleaded gasolines. Most of these studies have concentrated on the lower octane ranges (between 91 and 92.5 RON). The automotive manufacturers plan to initially produce engines requiring a minimum 91/83 RON/MON product. These are also the minimum specifications required by the EPA. There is some doubt as to whether these octane qualities will prove satisfactory over total engine life. It has also been noted that when refiners no longer have the flexibility to add lead for trim octane blending control, they will probably raise their blending target to prevent off-specification product. Thus, based upon results of the questionnaire, the average of actual product supply to the market place might be in the range of 91.5 to 92 octane number in order to guarantee a minimum 91. Nevertheless, the consensus of most of these studies is that at the low octane requirements, there is little manufacturing penalty for supplying this product versus the composite of conventional grades.

There are a variety of estimates of the current U.S. average clear octane pool. Actually there is no "fixed" clear pool quality since each individual refiner can change the clear octane of his pool by adjusting internal unit operations, such as catalytic reforming intake/severity, catalytic cracking intake/conversion, alkylation operations, etc. Each refiner will constantly monitor his plant operations and product blend requirements, and continually recalculate the optimum octane supply by comparing processing adjustments versus lead addition. We estimate a typical clear research octane number for the U.S. to be about 89 and the motor number to be about 81. The processing costs in a large (100,000 barrels a day), efficient refinery for increasing the clear pool octane from 89/81 to 91/83 is about 0.5 cents per gallon which is offset by the cost savings (also about 0.5 cents per gallon) from not purchasing and adding lead.[6]

There are increased distribution and marketing costs associated with supplying a new grade of gasoline and we estimate these costs will be about 0.5 cents per gallon.[7] Using a composite pump price for today's leaded regular and premium gasoline of 1.5 cents per gallon greater than leaded regular, and adding 0.5 cents per gallon for increased distribution/marketing cost, we arrive at a pump price for unleaded regular gasoline of 2.0 cents per gallon greater than leaded regular.

Unleaded Premium Gasoline

The supply economics for producing an unleaded premium gasoline (minimum 95/87 RON/MON) are not as well defined. One major oil company today supplies an unleaded premium gasoline of even higher octane specifications. However, this refiner also supplies leaded regular gasoline and, thus, has an outlet for very low octane blending stocks. This unleaded high octane premium grade is currently priced equivalent to competitive premiums, in some cases perhaps a 1.0 cents per gallon higher. Increasing the octane number of unleaded gasoline raises costs exponentially and incurs significant yield losses. It appears about the 95 to 96 clear research octane level represents a practical maximum for most gasoline pools.[8,9] We estimate increased manufacturing cost of about 3.0 cents a gallon will occur from increasing the clear octane from 91/83 to the 95/87 level and, thus, consider unleaded premium gasoline will be 3.0 cents a gallon higher than unleaded regular gasoline and, therefore, about 5.0 cents a gallon greater than the leaded regular grade.

Diesel Fuel (at present sulfur levels)

Present diesel fuel production from U.S. refineries represents about 4% to 5% of crude intake or about one tenth the yield of gasoline.[10] (The total distillate pool including furnace oil and distillate fuels for railroads, ships, etc. represents about 21% of crude intake). If a major shift in automotive engines occurred to diesel engines, it would take until 1980 before diesel fuel requirements became a significant percentage of total automotive fuel. The maximum diesel fuel yield from crude oil required from U.S. refineries by 1980 would only be in the range of 10% to 15%. We estimate this production level can be achieved fairly readily without significant additional processing costs and, thus, estimate a diesel value about 2.0 cents a gallon below leaded regular gasoline. Of course, total refinery product revenues must maintain an adequate return on capital investment for the composite of existing and new manufacturing facilities.

However, when diesel fuel production approaches 15% of refinery output, then major modifications to existing conversion facilities would have to be made to maximize distillate production instead of gasoline. This would be a cheaper operation than conventional refining because it would not be necessary to increase the octane number of this stream as is now practiced with gasoline. Therefore, we estimate the diesel fuel price post 1980 will be 1.0 cents a gallon below regular leaded gasoline. However, any large-scale introduction of diesel-powered automobiles into the U.S. car population could lead to severe diesel fuel supply/demand imbalances. Such a situation raises difficulties beyond the simple physical capability of the industry to produce diesel fuel, such as integration with other products like petrochemical feedstocks or hydrogen consuming low sulfur fuel oil. Product pricing must also consider return on existing refining investment, which was directed towards gasoline production. We believe that any policy decisions regarding major refinery product replacements must be precedented by a detailed, special study in cooperation with appropriate industry groups.

Fuel Suitable for TCCS (with no sulfur specifications)

This fuel quality has the least restrictive product specifications and, thus, would be the easiest to manufacture. This fuel can be produced merely by simple distillation from crude oil and will experience the least manufacturing cost. This product would offer the most flexibility[11] in balancing other naptha/light distillate product demands such as for petrochemical use, aviation fuels, and home heating requirements. Higher yields of this fuel can be produced than any other potential automotive fuel. The flexibility to divert hydrocarbon streams not suitable for supplying other conventional fuels will improve the supply economics for a TCCS quality product. Therefore, we have assumed a TCCS quality fuel would be priced 3.0 cents a gallon below regular leaded gasoline (or only 2.0 cents per gallon above crude costs). Again, if the total refinery motor fuel output were a TCCS fuel, pricing must be consistent with an adequate return on capital investment. Any policy decisions regarding replacements of major refinery products should be preceded by a detailed, special study in cooperation with appropriate industry groups.

Energy Consumption in Fuel Supply

U.S. refineries presently operate with about a 90% thermal efficiency in supplying energy to the market.[10] The U.S. Bureau of Mines statistics show that, in 1972, U.S. refineries consumed on the average 685,000 BTU of energy per barrel of crude oil processed (which represents 10.9%). This energy is consumed by refinery fuel systems and electric power to drive pump and compressor motors, and in combustion of catalyst coke.

To switch from conventional leaded gasolines to an unleaded regular gasoline would increase refinery energy consumption from about 10.9% to 11.0% of crude oil.[5] However, to supply a higher octane premium unleaded gasoline would increase this consumption to about 12.0%.[8]

To replace conventional motor gasolines with diesel fuel would reduce refinery energy consumption, perhaps to as low as 9% to 10% of crude when conventional gasoline was completely replaced with diesel fuel. Refinery energy consumption would be even lower in supplying a TCCS quality fuel, perhaps 7% to 8% of crude.

When considering alternative automotive fuels, it should be noted that if all the changes in refinery energy consumption on a crude oil basis are allocated solely to the volume of automotive fuel produced (about one half of the crude run), then the magnitude of each change is essentially doubled. However, care must be taken in evaluating the scenarios in which either diesel or TCCS fuel replaces gasoline. The U.S. petroleum industry markets products on a volume basis, and it is well known that a gallon of diesel fuel has about a 10% higher heating value than gasoline, primarily because it contains more pounds of hydrocarbons. When it is estimated that producing diesel fuel consumes 1% to 2% less energy oncrude (or 2% to 4% less energy based on the quantity of automotive fuel supplied), this means that about 3% more pounds of automotive fuel are supplied but the volume of diesel fuel would be about 7% less than if gasoline continued to be the prime product.

It is not realistic to optimize refinery energy consumption in isolation as one considers different automotive fuels, because the total fuel consumption requirements will change. For example, although there would be more energy consumed in supplying higher octane fuels, the only reason for supplying these higher octane products is to satisfy higher compression ratios in automotive engines which are inherently more efficient.[9] Overall energy balances (and cost benefit analyses) must be made to determine cost and energy consumptions for producing various quality fuels versus actual fuel consumption in the particular engine considered.

Investment Implications

It is difficult to assess how severe the investment implications for changes in automotive fuel supply will be, because of uncertainties in the elasticity of both petroleum consumption and supply to the much higher price levels now in effect. Some recent projections based on minimum demand[3] indicate that current U.S. refining capacity (including construction programs now underway) will provide sufficient crude capacity through 1980, with an additional 1 million barrels per day of capacity (to 17 total) required by 1985. If this is true, then the current construction bottlenecks could be relieved by the late 1970's and, thus, not inhibit the potential for changes in automotive fuel supply. However, the preponderance of petroleum industry estimates of the present survey indicate a domestic crude run of about 19 million barrels per day by 1985, leading to a $25 billion capital investment requirement, exclusive of lead or sulfur limitations on gasoline. A similar investment would be required for distribution and marketing. Based upon the survey, an additional $2 billion investment would be required through 1985 by U.S. refiners to produce unleaded regular gasoline in lieu of today's conventional mix. This level would increase to about $5 billion if it is necessary to manufacture an unleaded premium instead of regular.[8]

A lower investment would be required if diesel fuel were to be the prime (supplying greater than 50% of the automotive fleet by 1985) automotive fuel instead of motor gasoline. Perhaps $1 billion, less cumulative investment, would be required by refiners through 1985 than they would have spent if gasoline continued to be the prime product. The investment savings would be even greater for supplying a TCCS quality fuel, perhaps as much as another billion.

It would appear that the demand uncertainties are highly significant in determining the total capital investment requirements through 1985, with from $10 to $50 billion investment in refining and distribution required, depending upon the range of projections. In every case, unleaded gasoline investments represent a significant impact on total investment, but not in themselves sufficient to strain the construction industry. With the implications of overall U.S. demands on the construction industry, unnecessary additional contributions are, of course, to be avoided.

Sulfur Removal for Automotive Fuels

The sulfur content of today's leaded gasolines are relatively low[12] (about .04% weight for regular and about .03% weight for premium). The generation of sulfur dioxide by the combustion process in today's automotive engines is not normally considered a health hazard. Thus, there is no need at this time to further desulfurize conventional leaded gasolines. However, recently there has been some concern about emissions of sulfuric acid aerosols from vehicles equipped with catalytic converters. If these emissions prove to be an air quality problem, it might be necessary to reduce the sulfur content of unleaded gasolines to very low levels. If it is necessary to reduce the sulfur content of unleaded gasolines (perhaps to as low as .003% weight), there are additional economic and energy penalties. It has been estimated that the increased manufacturing costs to desulfurize either regular or premium unleaded gasoline will be about 1.5 cents a gallon,[13] which would be reflected in the pump price. Based upon survey results, we also estimate an additional $5 billion of capital expenditures would be required by the U.S. refining industry through 1985 to reduce the sulfur content, and we estimate refinery energy consumption would increase by about .4%.

Diesel fuel presently supplied in the U.S. today averages about .2% weight sulfur content[14] (or nearly 10 times the sulfur content of motor gasoline). Thus, if diesel fuel continues to be produced at this sulfur level and if it essentially replaced gasoline as the prime automotive fuel, then sulfur oxide emissions from vehicles would increase by a factor of nearly 10. Based upon survey results, the cost for reducing the sulfur content of diesel fuel would be of the same order of magnitude as for lead-free gasoline (i.e., about 1.5 cents per gallon, and it also would involve an additional investment of about $5 billion through 1985. Refinery energy consumption would increase by about .5% of crude to produce a diesel fuel with a sulfur content equivalent to today's motor gasolines. We estimate the economic and energy implications for supplying a low sulfur TCCS fuel would be about the same as for supplying a low sulfur diesel fuel.

REFERENCES

1 *International Petroleum Encyclopedia*, 1973.

2 Shell Oil Company, "The National Energy Outlook," 1973.

3 Arthur D. Little, Inc., "New Energy Sources - Business and Investment Implications," June 1974.

4 National Petroleum Council, "U.S. Energy Outlook," 1972.

5 NPRA Meeting, San Antonio, Texas, April 1973.

6 U.S. Environmental Protection Agency, "Impact of Motor Gasoline Lead Additive Regulations on Petroleum Refineries and Energy Resources - 1974-1980, Phase I," 1974.

7 Bonner and Moore Associates, "An Economic Analysis of Proposed Schedules for Removal of Lead Additives From Gasoline," 1971.

8 Arthur D. Little, Inc., "Overview - U.S. Refining Capability to Supply Proposed New GM Motor Gasolines," 1973.

9 Data submitted to the Committee on Motor Vehicles Emissions by Universal Oil Products, April 1974.

10 Bureau of Mines, Annual Petroleum Statements.

11 Coppoc, W.J. (Texaco) in letter to E.E. Petrick, January 23, 1974.

12 Bureau of Mines, Petroleum Products Survey, No. 83.

13 Arthur D. Little, Inc., "Capability of U.S. Refining Industry to Supply Low Sulfur Unleaded Gasoline," 1974.

14 Bureau of Mines, Petroleum Products Survey, No. 77.

APPENDIX I

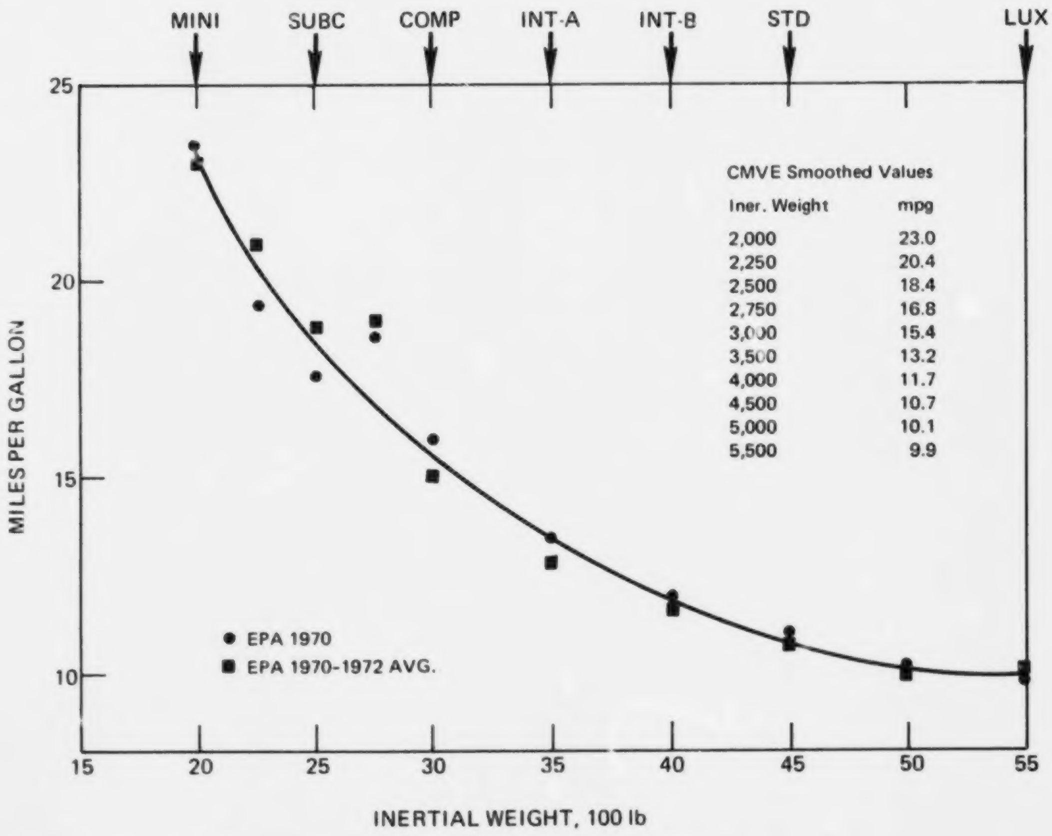
Vehicle Fuel-Economy Data

(Compiled by Earl W. Evans, James E.A. John,
Emerson W. Pugh, and Robert F. Sawyer)

For purposes of the CMVE study, it was necessary to create a composite set of data representing typical fuel economy for cars presently being produced and those which may be produced in the future. Fuel economy, as measured by the EPA, was the test method with typical 1970 cars being the basis of comparison. Data was required for all 34 different technologies listed in Table 3-2 and for seven car sizes in each class. These data were generated by the various consultants for CMVE with the assistance of the CMVE staff using a wide variety of sources including EPA certification results, data from their visits, and testimony to the government and to the CMVE. It should be noted that while the amount of data available is large, a substantial amount of technical judgment was involved in making these estimates.

The 1970 baseline fuel economy was obtained from the data listed in Appendix B of A Report on Automobile Fuel Economy by EPA of October 1973 by fitting a smooth curve through the data for 1970-1972. The curve for this baseline is included in Figure I-1. The actual fuel economies obtained for the seven vehicle classes used for CMVE, mini through luxury, are listed in Table I-1 for all classes of vehicle. In this listing, Class 22 is the 1970 baseline vehicle; this data represent the fuel economy baseline data.

The 1973 fuel economy was obtained from a smoothed curve fitted to average data for 1973 model year cars in Appendix B of the EPA report cited. Fuel economy for 1974 model year cars was assumed to be the same as in 1973. The change in fuel economy from the 1970 baseline to the 1973-1974 average is as follows:



CMVE Smoothed Values

Iner. Weight	mpg
2,000	23.0
2,250	20.4
2,500	18.4
2,750	16.8
3,000	15.4
3,500	13.2
4,000	11.7
4,500	10.7
5,000	10.1
5,500	9.9

FIGURE I1 CMVE Smoothed Fuel Consumption for Early 1970's Baseline Car by Inertial Weight. (Data from A Report on Automotive Fuel Economy, EPA, October 1973).

TABLE I-1

Fuel Economy (mpg) by Car Class and Size

(Zeros indicate that no estimate was made for these cars.)

	CAR SIZE						
CLASS*	MINI	SUBC	COMP	INT-A	INT-B	STD	LUX
1	23.0	18.4	15.4	13.2	11.7	10.7	9.9
8	23.0	18.4	14.5	12.1	10.4	9.2	8.5
15	23.0	18.4	14.5	12.1	10.4	9.2	8.5
22	23.0	18.4	15.4	13.2	11.7	10.7	9.9
29	23.0	18.4	14.5	12.4	11.0	9.7	9.0
36	24.2	19.1	15.9	13.5	11.8	10.8	10.0
43	23.7	18.6	15.4	13.1	11.5	10.4	9.5
50	23.7	18.6	15.4	13.1	11.5	10.4	9.5
57	22.5	18.0	13.7	11.7	10.4	8.8	8.1
64	23.0	18.4	14.2	12.3	10.8	9.6	8.9
71	23.0	18.4	14.6	12.3	10.8	9.6	8.9
78	21.8	17.5	13.4	11.5	10.2	9.1	8.4
85	23.9	19.1	15.2	13.1	11.5	10.2	9.4
92	19.6	15.1	13.6	9.9	8.4	0.0	0.0
99	25.5	20.4	16.0	13.7	12.1	11.2	10.4
106	24.4	19.3	15.2	12.9	11.5	10.6	9.8
113	23.9	19.1	15.1	12.9	11.3	10.2	9.4
120	29.0	24.1	19.0	17.0	13.1	12.3	10.5
127	23.2	18.5	14.8	12.5	11.0	9.8	9.0
134	24.2	19.1	15.9	13.5	11.8	10.8	10.0
141	23.7	18.8	15.6	13.2	11.5	10.3	9.3
148	24.2	19.3	14.9	12.8	11.3	10.1	9.3
155	26.0	20.6	17.1	11.9	12.6	11.4	10.4
162	21.6	17.3	13.7	11.7	10.4	0.0	0.0
169	21.6	17.3	13.7	11.7	10.4	0.0	0.0
176	29.2	23.2	19.4	16.5	14.6	0.0	0.0
183	17.1	14.2	11.2	10.0	7.7	7.3	6.2
190	29.2	23.2	19.4	16.5	14.6	13.3	12.3
197	27.6	21.7	17.9	15.0	13.1	11.8	10.7
204	25.5	20.4	16.0	13.7	12.1	11.2	10.4
211	27.1	21.5	18.0	15.4	13.7	12.4	11.5
218	23.0	18.4	15.3	12.9	11.4	10.4	9.6
225	22.5	18.0	14.8	12.2	10.5	9.4	8.7
232	22.3	21.8	14.2	12.2	10.8	0.0	0.0

* The configurations of vehicles in each class are given in Figure 3-2.

Mini and subcompact--same as 1970
Compact (3,500 lb)--6% less than 1970
Standard (4,500 lb)--14% less than 1970

The miles per gallon for all technologies as listed in Table I-1 were estimated from this base by the various consultants for CMVE with the assistance of the CMVE staff. The rationale for these estimates are summarized below.

Conventional ICE

Fuel economy for vehicles equipped with control systems designed to meet the 1975 Federal Emissions Standard are based on the following technical considerations:

1) Catalyst cars can have their spark advance and EGR optimized for fuel economy and will, therefore, have the largest fuel economy gain over 1974 vehicles, i.e., 5% for mini, up to 15% for standard and luxury. This results in fuel economies about equal to the 1970 baseline for standard and luxury and a 5% improvement over 1970 for the mini;

2) The use of air pumps above is a systems-design decision which is assumed not to effect fuel economy; and,

3) Cars with only EGR or EGR and air pump will have the same fuel economy as similar 1973-74 cars for mini- and subcompact cars and up to a 5% improvement for standard and luxury cars. Fuel economy improvements in larger cars are a result of secondary changes not necessarily related to emission controls.

Large cars meeting the 1975 California Emissions Standards are assumed to have fuel economies about 8% less than a vehicle with a similar control system (such as air pump, EGR, and oxidizing catalyst) meeting the 1975 Federal Emissions Standards. However, the change to proportional EGR (PEGR) gives a little better fuel economy so that large cars are about 4% less than the 1970 baseline and small cars are about 1% better than the 1970 baseline due to other improvements.

Conventional engines are assumed to be able to meet the 1977 Federal Emissions Standard with only minor extensions of their present control systems. General Motors states in their status report that fuel economy will be 7% better than 1974, whereas, Ford states that it will get a 5%-13% penalty compared to 1975. Both of these statements are equivalent to a 2%-10% loss in fuel economy compared to California-75 cars. However, variable venturi carburetors, which give better mixture control, and improved quick-heat manifolds were assumed to be standard equipment on the conventional ICE meeting the I77 standard (Class 50). Hence, it has been assumed that these cars will have slightly better fuel economy than the manufacturers predict. Also, since certification data shows C-75 systems are easily meeting the HC and CO standards, we assume no fuel economy loss from C-75. Recent data on fleet vehicles operated by the California Highway Department tend to support this conclusion.

In order to meet the 1978 Federal Emissions Standards by 1978, reducing (NO_x) catalysts will be required. Three-way catalyst systems with feedback control are assumed to be the one important system. General Motors states in their status report to EPA that there will be a 15% improvement in fuel economy over 1974, while Ford states in their status report that there would be a 15%-23% penalty from 1975. In terms of 1974, this appears to be a penalty of 0%-10%. We believe greater use of PEGR, required because of poor durability of reducing catalysts, will result in a 2%-7% penalty over catalyst-equipped cars meeting the Federal 1973 Emissions Standards.

Another promising configuration for meeting the 1978 standard is the dual-catalyst system with an oxidizing catalyst upstream of the reducing catalyst to prevent damaging oxygen-rich mixtures from reaching the reducing catalyst. Because the system must operate on the rich side of stoichiometry, it will have some fuel economy penalty. We assumed a 3% penalty compared to the 3-way catalyst system.

Stratified-Charge Engine with Pre-chamber

The fuel economy for the stratified-charge engine with pre-chamber and lean thermal reactor (LTR) is based primarily on Honda test results. Because it operates lean, an uncontrolled Honda should get about 5% better fuel economy than an uncontrolled conventional engine of equivalent compression ratio and horsepower and still be able to meet the Federal 1975 Emissions Standard.

In order to meet the California 1975 Emissions Standards, a slight penalty may be incurred (1%-2%).

The stricter HC control required to meet the 1977 Federal Emissions Standard would cause a fuel-economy penalty compared to the cars meeting the 1975 California Emissions Standard. A 0%-4% penalty over C-75 was assumed.

With regard to the 1978 Federal Emissions Standards, the increased use of EGR with an already marginal combustion process will result in large fuel economy penalties.

The Honda data indicate that the fuel economy of the 2,000 lb vehicle decreases from 28.4 to 19 mpg to meet the 1978 standard. This is a 30% penalty due primarily to the use of PEGR. Consistent with this result, we assumed a 19%-24% penalty over catalyst cars meeting the Federal 1975 Emissions Standard.

Wankel Engine

The fuel economy for the Wankel is based primarily on the latest certification results supplied by the Toyo Kogyo Company on its Wankel engine with a lean thermal reactor, and to a lesser extent is based on more optimistic (but less well documented) reports from GM, Curtiss-Wright, and others. The lower theoretical efficiency and technical problems of getting good seals are partly offset by the lighter weight engine. Therefore, only a 3% penalty is assumed over a conventional ICE of equivalent performance and with similar control systems meeting the same 1975 Federal or California Emissions Standard.

The high HC emissions will cause the Wankel to suffer in meeting the 1977 Federal Emissions Standard. A 4%-6% penalty was, therefore, assumed compared to vehicles meeting the C-75 standard. In order to meet a stricter NO_x standard at the same 1977 HC and CO standard, it would probably be necessary to use a reducing catalyst. With a dual-catalyst system, the Wankel would not suffer much fuel economy penalty and due to other system improvements, the net result would be a slightly better fuel economy than 1970 baseline vehicles.

There is probably little chance of meeting the 1978 NO_x standard unless a stratified-charge design were used. This concept is not developed to the stage where fuel economy could be predicted. Therefore, this system was not included in 1978.

Fuel Injected, Stratified-Charge Engine

The fuel economy for the fuel-injected, stratified-charge engines, such as the Texaco TCCS and the Ford PROCO, are based primarily on data from Texaco with some caution inserted by information from foreign licensees. We placed the economy between an uncontrolled ICE and a diesel and closer to the diesel, i.e., 16%-18% better than an uncontrolled, conventional ICE.

Using an oxidizing catalyst to reduce the HC emissions, the maximum fuel economy would result in NO_x emissions below 2 g/mi. Therefore, no fuel economy penalties would be incurred until emissions were reduced below 1 g/mi. At this emission level, the fuel economy penalty would be expected to be about 3%-9% with the higher value for larger cars because of the larger amounts of EGR required in heavier vehicles.

In order to meet the 1978 standard, a larger penalty could be expected so that a 13%-20% fuel economy penalty was assumed when compared to uncontrolled vehicles using this class of engine.

Diesel

The fuel economy for the diesel is assumed to be about 24%-28% better than the conventional, uncontrolled engine based primarily on the Southwest Research Institute report, discussions with Ricardo, and data from Daimler-Benz. Equal performance was assumed although a weight penalty of 100, 150, and 200 lb for SC, C, and I-S-L was assumed and factored into the final economy estimates and a larger displacement engine is required, e.g., a 400 CID diesel replaces a 350 CID ICE in the large cars.

Emissions from the diesel without controls will be within the 1977 standard so that no fuel economy penalty would be expected until the NO_x level is reduced below 2 g/mi. At 1 g/mi NO_x, the EGR required would cause a larger penalty on large cars than small. A 7%-16% penalty over uncontrolled was, therefore, assumed. The diesel was not assumed to meet standards below 1 g/mi NO_x.

Numerical data on fuel economy by vehicle class and size are summarized in Table I-1.

APPENDIX J

Vehicle Maintenance Data

(Compiled by R. Robert Brattain, James E. A. John, and LeRoy H. Lindgren)

The vehicle maintenance data is defined in this study as the maintenance costs associated with emissions and fuel distribution systems. It is assumed that all other vehicle maintenance costs will not change due to the introduction of new emission or fuel-distribution systems.

The fundamental concepts used by the various consultants for CMVE to develop the maintenance costs for each vehicle configuration are:

Conventional ICE Engines

1. Low-lead gasoline will increase the life of spark plugs from 15,000 miles, typical of engines run with leaded gasoline, to 30,000 miles.

2. Distributor points, condensor, and tuneup costs will be eliminated by the introduction of electronic distributors. The only exception to this statement is a timing check cost at 30,000 miles when the spark plugs are replaced.

3. Since the catalytic converter system is designed to have in excess of a 50,000 mile life, catalyst replacement costs are not included in the maintenance cost schedule.

4. Some reduction in carburetor maintenance is anticipated, in spite of the fact that a more sophisticated carburetor design is planned for post-1975/76 vehicles.

5. The transmissions control system for spark advance control requires less maintenance in 1975 systems than previously.

6. Improvements in PCV and EGR valves have resulted in reduced maintenance costs for the 1975/76 systems.

7. Design improvements have been introduced into the fuel evaporation and the air distribution system resulting in the increase of service interval and the reduction of the maintenance costs over 50,000 miles.

8. The air-injection system is assumed to require no maintenance over 50,000 miles.

The alternative engines and major modifications of the conventional engine have significantly different maintenance schedules and associated costs. The maintenance costs used in this study are summarized in Table J-1. Special assumptions regarding maintenance by engine type follow.

Nonconventional Engines

The CVCC (Honda) engine (classes 85, 225, and 92) requires additional carburetor, choke, and spark/fuel control components and thereby requires an increase in maintenance costs over the 1975 catalyst-equipped vehicles. The additional valving system is expected to require no maintenance (beyond normal oil changes) over the 50,000 miles.

The TCCS or PROCO stratified-charge engines (classes 211 and 155) are expected to require additional maintenance on a 1970 car (class 22) due to the increase in the number of spark plugs required by the PROCO design. Some increase in maintenance for the PROCO was also predicted because of the more sophisticated fuel delivery system. The European version of the TCCS will also require an increase in maintenance over the 1975 catalyst-equipped cars with carbureted fuel systems.

The diesel engine (classes 190 and 197) already has the reputation for having low maintenance costs. Therefore, it was assumed

TABLE J-1

Summary of Fuel and Emissions-Related Maintenance Data

(The number listed is the average yearly cost ($/year) for the first 50,000 miles of vehicle life; zeros indicate that no data were developed for these cars.)

CLASS	CAR SIZE						
	MINI	SUBC	COMP	INT-A	INT-B	STD	LUX
1	46.0	48.0	52.0	66.0	66.0	82.0	82.0
8	52.0	56.0	58.0	70.0	70.0	88.0	88.0
15	48.0	50.0	52.0	74.0	74.0	82.0	82.0
22	32.0	36.0	40.0	44.0	44.0	52.0	52.0
29	55.0	55.0	58.0	70.0	70.0	87.0	87.0
36	40.0	43.0	45.0	52.0	52.0	67.0	67.0
43	42.0	45.0	47.0	53.0	53.0	69.0	69.0
50	40.0	45.0	47.0	53.0	53.0	69.0	69.0
57	40.0	46.0	48.0	53.0	53.0	70.0	70.0
64	32.0	48.0	50.0	50.0	58.0	72.0	72.0
71	32.0	48.0	50.0	50.0	58.0	72.0	72.0
78	32.0	48.0	50.0	50.0	58.0	72.0	72.0
85	50.0	52.0	52.0	70.0	70.0	81.0	81.0
92	50.0	54.0	54.0	62.0	62.0	83.0	83.0
99	44.0	48.0	50.0	57.0	57.0	72.0	72.0
106	44.0	48.0	50.0	57.0	57.0	72.0	72.0
113	44.0	48.0	50.0	57.0	57.0	72.0	72.0
120	0.0	0.0	0.0	0.0	0.0	0.0	0.0
127	32.0	41.0	50.0	50.0	58.0	72.0	72.0
134	38.0	43.0	45.0	45.0	49.0	67.0	67.0
141	42.0	45.0	47.0	47.0	60.0	69.0	69.0
148	42.0	45.0	47.0	47.0	60.0	69.0	69.0
155	42.0	45.0	47.0	47.0	60.0	69.0	69.0
162	36.0	38.0	44.0	48.0	48.0	0.0	0.0
169	50.0	52.0	52.0	71.0	81.0	0.0	0.0
176	44.0	48.0	48.0	68.0	68.0	0.0	0.0
183	0.0	0.0	0.0	0.0	0.0	0.0	0.0
190	30.0	33.0	33.0	38.0	38.0	50.0	50.0
197	34.0	37.0	37.0	42.0	42.0	54.0	54.0
204	44.0	48.0	50.0	57.0	57.0	72.0	72.0
211	40.0	43.0	45.0	45.0	58.0	67.0	67.0
218	32.0	48.0	50.0	50.0	58.0	72.0	72.0
225	40.0	46.0	48.0	53.0	53.0	70.0	70.0
232	44.0	48.0	48.0	68.0	68.0	0.0	0.0

that the automotive light-duty design proposed in this study would have maintenance costs lower than those of the baseline 1970 vehicle. The EGR on the diesel in class 197 was presumed to increase the maintenance slightly.

The Wankel or rotary engine (class 169) has a warranty on the thermal reactor system to cover all replacement costs over 50,000 miles, so no maintenance for the air-injection or manifold system was predicted. Since some designs include two spark plugs and additional distributors, an increase in maintenance costs for the rotary engine designs was predicted. More recent data indicate that the single distributor designs are now available.

The electronic fuel-injection systems are relatively maintenance-free if the electronic component reliability is held to design projections. The feed-back systems do, however, require replacement of the sensors every 10,000 miles. Therefore, there is some maintenance penalty for EFI compared to the carbureted systems planned for 1975/76.

Our Panel of Consultants on M/C and the Costs Benefits Committee decided to present the costs for the replacement of catalyst systems as a separate cost element, since there is still considerable controversy over the necessity of schedule for maintenance of catalytic systems over the total life of the car. Catalytic unit replacement costs are summarized in Table J-2. These data are not included in the vehicle maintenance costs presented in Table J-1, but are available for future computation should a regulatory inspection system introduced for emission diagnosis and replacement be mandated.

TABLE J-2

Cost to Replace All Catalytic Converters in
Each Car Having Them (in dollars)

	CAR SIZE						
LASS	MINI	SUBC	COMP	INT-A	INT-B	STD	LUX
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	87.0	87.0	87.0	114.0	114.0	114.0	114.0
43	87.0	87.0	87.0	114.0	114.0	114.0	114.0
50	87.0	87.0	87.0	114.0	114.0	114.0	114.0
57	88.0	88.0	88.0	156.0	156.0	156.0	156.0
64	198.0	198.0	198.0	225.0	225.0	225.0	225.0
71	285.0	285.0	285.0	312.0	312.0	312.0	312.0
78	199.0	199.0	199.0	267.0	267.0	267.0	267.0
85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92	87.0	87.0	87.0	114.0	114.0	0.0	0.0
99	87.0	87.0	87.0	114.0	114.0	114.0	114.0
106	0.0	0.0	0.0	0.0	0.0	0.0	0.0
113	0.0	0.0	0.0	0.0	0.0	0.0	0.0
120	0.0	0.0	0.0	0.0	0.0	0.0	0.0
127	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	100.0	100.0	100.0	135.0	135.0	135.0	135.0
141	100.0	100.0	100.0	135.0	135.0	135.0	135.0
148	100.0	100.0	100.0	135.0	135.0	135.0	135.0
155	87.0	87.0	87.0	114.0	114.0	114.0	114.0
162	0.0	0.0	0.0	0.0	0.0	0.0	0.0
169	88.0	88.0	88.0	156.0	0.0	156.0	0.0
176	87.0	87.0	87.0	114.0	114.0	0.0	0.0
183	0.0	0.0	0.0	0.0	0.0	0.0	0.0
190	0.0	0.0	0.0	0.0	0.0	0.0	0.0
197	0.0	0.0	0.0	0.0	0.0	0.0	0.0
204	87.0	87.0	87.0	114.0	114.0	114.0	114.0
211	87.0	87.0	87.0	114.0	114.0	114.0	114.0
218	198.0	198.0	198.0	225.0	225.0	225.0	225.0
25	88.0	88.0	88.0	156.0	156.0	156.0	156.0
32	285.0	285.0	285.0	312.0	312.0	0.0	0.0

APPENDIX K

Sticker List Price Data

(Compiled by LeRoy H. Lindgren)

The vehicle list price data used in this study are based on manufacturing costs estimates generated by the CMVE Panel of Consultants on Manufacturability and Costs. These manufacturing costs are based on component costs obtained from several sources:

1. Vendor OEM costs to the industry obtained by the Panel of Consultants on M/C.
2. Industry cost data supplied on the questionnaire submitted to the U.S. companies by the Panel of Consultants on M/C (Appendix B).
3. Selling price data supplied by car dealers, automotive supply catalogs, and automotive service centers.
4. Computations by the Panel of Consultants on M/C using cost per pound reference data to confirm the estimates.

In the automobile industry, the sticker list prices are developed from a build up of costs based on economic production volumes. Figure K-1 illustrates the build up of costs and their relationships.

In such a discussion as the present one, it is proper to define language. As used here, these terms are:

A. Variable Costs. The labor and material costs that are sensitive to volume. In the estimates used by the Panel of Consultants on M/C, it was assumed that economic volumes were achieved.

B. Fixed Costs. Those costs that are applied to variable costs that represent overhead, materials, labor, and expenses.

C. Factory Costs. The summation of variable and fixed costs as well as the amortization of tooling and equipment. Also included in the factory costs

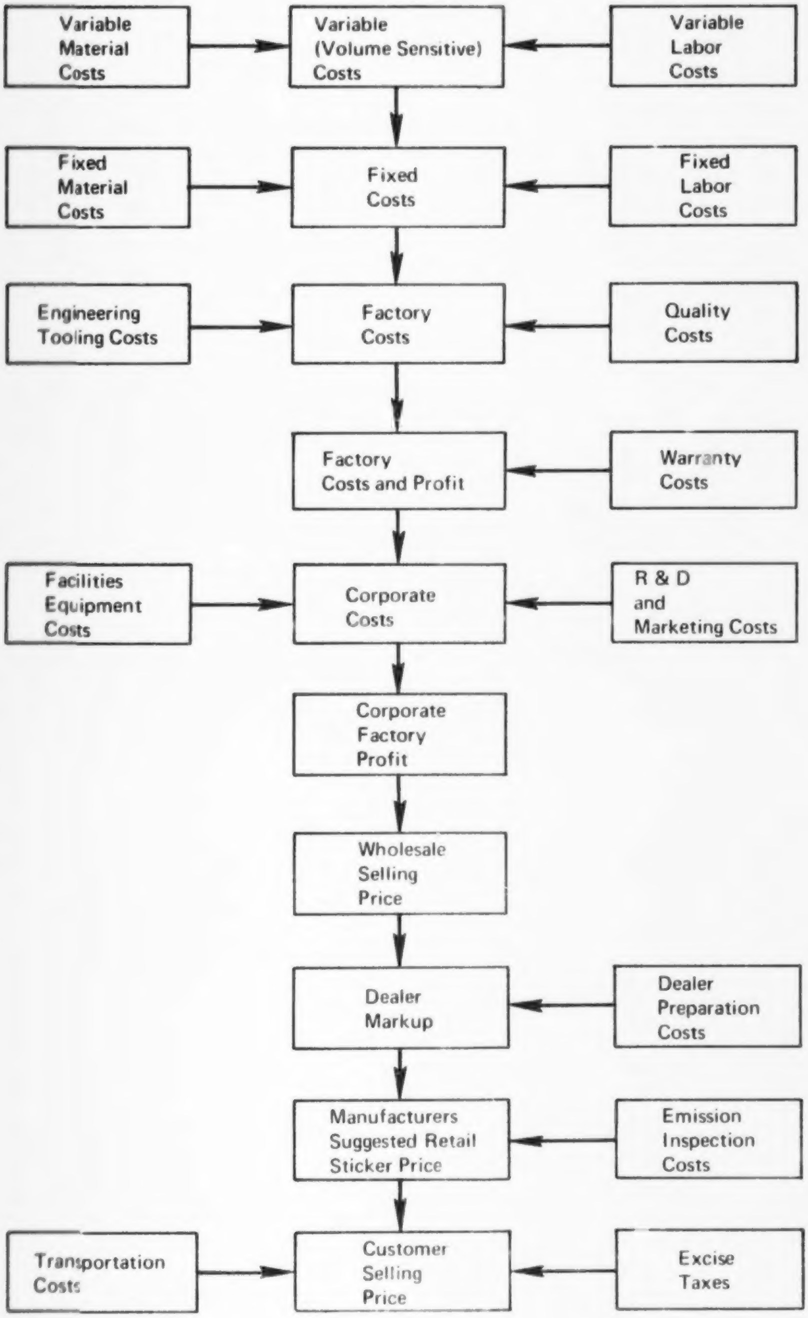

Variable Material Costs
Variable (Volume Sensitive) Costs
Variable Labor Costs
Fixed Material Costs
Fixed Costs
Fixed Labor Costs
Engineering Tooling Costs
Factory Costs
Quality Costs
Factory Costs and Profit
Warranty Costs
Facilities Equipment Costs
Corporate Costs
R & D and Marketing Costs
Corporate Factory Profit
Wholesale Selling Price
Dealer Markup
Dealer Preparation Costs
Manufacturers Suggested Retail Sticker Price
Emission Inspection Costs
Transportation Costs
Customer Selling Price
Excise Taxes

FIGURE K1 Cost Structure in Automotive Manufacturing.

are the warranty costs of the products that the factory produces. A profit is applied at the factory level. These factory costs, which include some production design engineering costs, are often compared to vendor prices for the same product at equivalent volumes to ascertain make-or-buy decisions at the purchasing levels. Each automotive production factory maintains a competitive cost position to outside vendors for the same product.

D. Corporate Costs. The factory costs are assigned a share of the corporate costs which includes general and administrative costs as well as the investment allocation for new product tooling, equipment, and facilities. It is here that the pay back of investments period is defined over the appropriate production and the resultant additional investment cost is added to the vehicle price. Also included are research and development and marketing costs.

E. Corporate Profit. The corporate profit is assigned at this level of costing.

F. Wholesale Selling Price. This is the factory delivered selling price FOB Detroit. This is the selling price that is used to compute company sales dollars.

G. Dealer Markup. The dealer markup is the multiplier factor used to assign the dealers share of vehicle selling price. The markup percentage is 22% of sticker list price for the base vehicle. The customer options or accessories have another markup that is around 40% of the option or accessories add-on selling price. These options are not considered in our basic car configuration. We are considering as standard equipment: power steering and brakes and air conditioning in our basic car prices.

H. Dealer Preparation Costs. These costs are assigned by the manufacturer to each vehicle delivered to the dealer for the costs of cleaning up the car to the customer's satisfaction. These costs are not considered in the price of the vehicle in this study.

I. Transportation Costs. These are the direct transportation costs assigned to the vehicle to cover the costs of delivery to the dealer. These costs are not considered in this study.

J. Warranty Costs. These costs are the costs of warranty that are required to cover the costs of labor and material to replace premature failures within warranty periods. These costs are assigned to specific products at the factory level and are included in the factory costs. These costs are measured separately so that actual failure costs of a product are charged back to the factory. If these budgeted costs are exceeded at the factory, the managers and engineers take corrective action to eliminate the excess costs. The study cost data includes the warranty costs in the manufacturing costs.

K. Emissions Inspection Costs. These costs are add-on costs in California to cover the costs of emission testing of a percentage of the production vehicles shipped to or produced in California. These costs are not considered in this study, since the other states do not require production testing for emissions.

The customer selling price is the summation of the prior costs plus applicable taxes. The customer selling price involves some discounting due to trade-ins and customer negotiations (which are also not considered in this study).

The study as prepared by the Panel of Consultants on M/C does not attempt to develop the detailed costs as defined above. Instead, the Panel of Consultants on M/C developed the manufacturing costs of the significant components of the vehicle and engine (see Appendix C). Then by developing a gross markup factor curve for a given base manufacturing cost, a nominal (pre-investment) selling price was computed for each individual vehicle. The equations for the markup factor and nominal selling price are:

Markup Factor = .00029176 x Manufacturing Cost + 1.40833 (Eq. K1)
Nominal Selling Price = Markup Factor x Manufacturing Cost (Eq. K2)

The relationship between the markup factor and the manufacturing cost is plotted in Figure K-2.

It is to be noted that the CMVE curve was revised from previou CMVE data. This was done to reflect more realistically the current i dustry position of establishing the costs and prices of the smaller vehicles. The shift to smaller sizes has created the need to increase the markup of smaller vehicles in order to hold the gross levels of industry profit at the past levels. The adjusted line, representing about a 12% increase in a subcompact car, was an estimate based on the best judgment of the Panel of Consultants on M/C.

The cost methodology of the Panel of Consultants on M/C is compared to industry's pricing methods in Table K-1. The comparison illustrates that the industry factory costs and the CMVE manufacturing costs are equal. The Panel of Consultants on M/C does not identify t warehouse selling price, so no comparisons can be made at this level. The sticker list prices, however, are again equal.

The computed vehicle sticker prices are included in Table K-2 for each vehicle configuration in the data base.

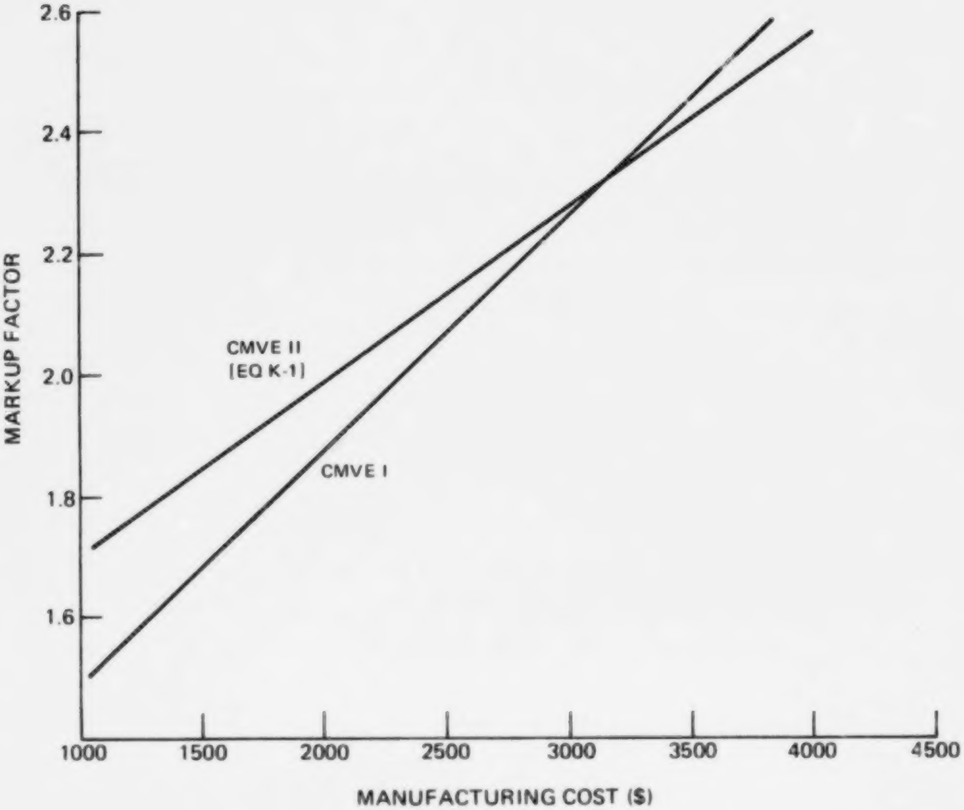


FIGURE K2 Relationship of Markup Factor to Manufacturing Cost.

TABLE K-1

Comparison of Industry and Panel of Consultants on M/C Methods of Vehicle Costing for Vehicle 9 (a 1971-72 Subcompact) in Scenario B

Automotive Industry's Procedure[1]			Panel of Consultants on M/C Procedure
Factory Cost	1,355	1,355	Manufacturing Cost
Tooling Amortization (.02 x SLP)	49		
Corporate G & A (.10 x SLP)	245		
Corporate Profit (.10 x SLP)	245		
Investment	14		
		1,088	Total Dollars of Markup (for illustration, not normally calculated)
Warehouse Selling Price	1,908		
Dealers Markup (.22 x SLP)	538		
Sticker List Price (SLP)	2,446	2,443	Nominal Selling Price = 1.8035 (from Eq.K1) x (Mfg. Cost)
		3	Scenario Investment (B)
Sticker List Price (SLP)	2,446	2,446	Sticker List Price (SLP)
Dealers' Preparation Charges	40		
Transportation Costs	75		
Emissions Insp. Costs (Calif. Only)	10		
Suggested Customer Price	2,571		

---

[1] The percentages used are from the NAS report entitled Manufacturability and Costs of Proposed Automotive Engine Systems, January 1973, p. 14.

TABLE K-2

Nominal Selling Prices (in dollars) by Car Size Developed by the Panel of Consultants on M/C Method

	CAR SIZE						
CLASS	MINI	SUBC	COMP	INT-A	INT-B	STD	LUX
1	2132.38	2401.25	3351.99	3992.61	4021.00	5305.39	7676.34
8	2172.66	2442.92	3398.22	4041.68	4070.19	5359.82	7739.29
15	2139.78	2408.91	3360.49	4001.63	4030.04	5315.41	7687.92
22	2132.38	2401.25	3351.99	3992.61	4021.00	5305.39	7676.34
29	2205.68	2474.86	3431.20	4066.30	4105.27	5389.99	7760.87
36	2234.76	2504.93	3464.53	4101.62	4163.97	5454.85	7835.77
43	2268.04	2539.33	3502.64	4142.02	4204.58	5499.70	7887.54
50	2276.65	2548.23	3512.50	4168.15	4215.09	5511.30	7900.93
57	2230.27	2500.28	3449.56	4169.20	4203.27	5498.25	7872.50
64	2356.75	2631.00	3604.15	4265.37	4323.28	5630.71	8038.64
71	2389.67	2665.01	36[illegible]1.79	4294.68	4363.37	5674.93	8076.09
78	2395.79	2671.33	3638.78	4472.64	4486.07	5810.19	8231.71
85	2169.69	2437.64	3448.09	4180.20	4219.55	5580.20	7983.77
92	2248.70	2497.40	3492.30	4140.98	4248.49	5612.30	8020.78
99	2270.41	2541.77	3513.74	4181.50	4228.49	5526.10	7918.00
106	2272.56	2544.00	3525.09	4184.12	4207.73	5503.18	7891.56
113	2300.81	2573.20	3570.61	4216.13	4255.61	5620.18	8029.87
120	2373.52	2648.33	3654.01	4304.47	4344.24	5718.41	8143.07
127	2378.75	2653.73	3642.52	4318.73	4347.57	5663.14	8093.55
134	2354.79	2628.98	3619.33	4276.19	4307.91	5613.76	8019.09
141	2410.44	2686.47	3683.04	4351.68	4355.66	5666.43	8079.80
148	2393.82	2669.30	3699.10	4339.46	4448.79	5745.50	8062.58
155	2280.96	2552.68	3569.38	4202.22	4259.83	5619.02	8011.69
162	1943.41	2209.10	2996.96	3513.74	3513.74	4818.71	6828.87
169	2008.64	2276.66	3070.99	3561.94	3561.94	4872.61	6890.49
176	2007.81	2275.79	3070.04	3590.72	3612.86	4929.49	7099.10
183	2130.27	2402.57	3208.81	3736.81	3736.81	5141.13	7197.10
190	2257.29	2514.90	3530.77	4132.62	4247.97	5614.63	8117.33
197	2264.82	2522.66	3539.42	4141.76	4257.19	5624.86	8129.18
204	2293.90	2566.06	3584.26	4262.73	4310.04	5616.09	8021.79
211	2273.42	2544.89	3560.70	4193.04	4250.60	5608.79	7999.91
218	2326.35	2599.59	3559.46	4217.97	4286.23	5589.82	7978.05
225	2223.84	2493.64	3442.21	4116.98	4150.90	5498.25	7872.50
232	2193.52	2468.02	3280.38	3812.12	3839.80	5182.72	7244.52

APPENDIX L

Methodology for Calculating Investment Costs for Alternate Scenarios

(Written by Merrill L. Ebner)

The purpose of the investment programs[1] is to measure the comparative impact of a particular scenario on domestic automobile manufacturers. Hence, only the basic or domestic parts of each scenario (see Appendix F) are used in these assignments. The investment cost for a given scenario is not calculated in absolute terms, but rather as the increment over the comparable costs for Scenario A. Scenario A, it will be recalled, assumes that 1970 emissions standards are continued through 1985. Incremental costs are used because (a) they are the most relevant in assessing the relative cost of different scenarios and (b) they avoid assigning a current value to 20 year old plants for which the investment was recovered long ago, as would be necessary in a total investment accounting.

The basic scheme used is to identify 273 different types of automotive production facilities. For reference, a "resources-used" table is kept which specifies which production facilities are required for each configuration of vehicle which may be produced. Different kinds of production facilities are defined as different resources. A resource could be a foundry to make intake manifolds, an engine metal-cutting transfer line for 350 CID engines, a carburetor assembly line, or some other identifiable unit of productive capacity.

An overview of the procedure for calculating investment costs is shown schematically in Figure L1. As can be seen, the primary inputs are the scenarios or hypothetical production plans. Two scenario inputs are used: the baseline scenario (Scenario A) and

---

[1] The procedures to be described here were organized as computer programs.

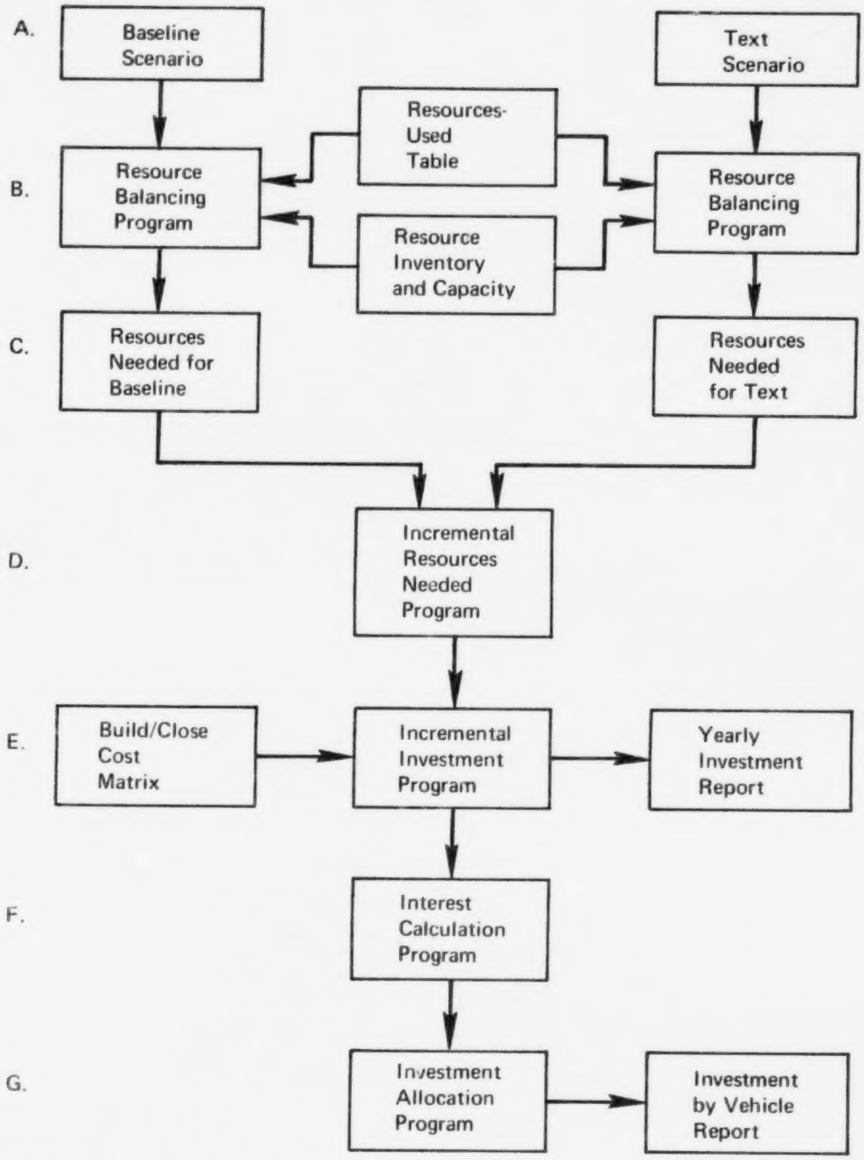

A.
Baseline Scenario
Text Scenario
Resources-Used Table
B.
Resource Balancing Program
Resource Balancing Program
Resource Inventory and Capacity
C.
Resources Needed for Baseline
Resources Needed for Text
D.
Incremental Resources Needed Program
E.
Build/Close Cost Matrix
Incremental Investment Program
Yearly Investment Report
F.
Interest Calculation Program
G.
Investment Allocation Program
Investment by Vehicle Report

FIGURE L1 Schematic of the Procedure for Calculating Investment Costs.

the test scenario (any one of the other 18 in Table F1). Each of these are considered separately in steps A through C in a completely analogous fashion, as will be described.

For each resource, a standard yearly capacity has been specified in the Resource Capacity file. This value, the estimated yearly production for a two-shift, five-day week, is relatively constant for a given resource since these are mostly high-volume transfer lines. To load the scenario into the production resources, the volume of cars of a given configuration to be produced in a given year is selected from the scenario input table. This volume is then loaded in the same year in all of the resources used by this car, as indicated in the resources-used table. The load impact is expressed in "standard plant" units by dividing the car volume in the scenario by the standard volume for each resource expressed as the standard number of units to make one car.[2] This process is continued and a yearly tally is kept by resource, car by car and year by year, until the complete scenario is loaded. The result is the yearly load imposed on each of the 273 resources by the scenario.

The next step is to match the pattern of available plants to the number of standard plants needed, realizing that the operations manager would tend to use variations in utilization whenever possible to smooth his investment in new capacity. For this purpose, a simple decision matrix was incorporated into the computer calculation which was roughly equivalent to a very conservative operations comptroller of very average intelligence. Decision parameters were set based on the initial utilization and the long term trend in capacity for that particular resource. With some minor variations, the program would begin in 1974, the first year in which he could decide to build a new plant,[3] look ahead to his projected utilization, and build a new line if his utilization was over 1.6 or close a resource if the utilization was below 0.7. But only one new resource could be added or removed in any one year. In this way, the number of resources of a a given type (e.g., the number of engine lines to make 350 CID V-8 engines) were obtained year by year for each resource. The baseline and test scenarios would be treated in like fashion and the results summarized as report C in Figure L1. At this stage, the total number of resources of a given type, resource by resource and year by year, would be indicated.

---

[2] To illustrate, the standard volume per car for a tire line is 1,000,000 units per year, or one fifth the actual production rate of 5,000,000 tires per year, since there are five tires per car.

In Step D of Figure L1, the incremental resources needed were summarized resource by resource. This program would select a given resource, go to the base line Resources Needed file, and scan along it noting the years in which the number of resources increased or decreased by one. Years in which there is no change would be marked "0" and those in which there is a change by +1 or -1, as appropriate. The same procedure is used on the same resource in the test scenario, and then the procedure is repeated for the next resource until all are complete. The result is two strings of 0's and ± 1's, one for the baseline scenario and one for the test scenario, for each of 273 resources. These represent the change in resources needed to effect the two scenarios.

The next step, Step E in Figure L1, is to assign an investment value to the changes in resources determined in Step D. One part of this problem is to assign a dollar value to building or closing a unit of a particular type of resource. The solution was to build a matrix of building and closing costs resource by resource called the Build/Close Cost Matrix. The cost to "build" included the cost of the facility, the cost of the equipment, and the cost of installing the equipment. The cost to "close" imagines that the facility is deactivated, the equipment is removed, the space is rehabilitated, and the facility is sold out of the automotive sector. Labor to remove the equipment is taken as 50% of the cost to install it, equipment is sold at 3% of new value for transfer lines and 20% for standard equipment, and the restored space is sold after renovation for 62% of its cost to build. Using these procedures and a variety of industry cost data, the costs to build and close one unit were obtained for each of the 273 resources.

---

[3] And also the year in which the existing plant inventory had been determined.

With each investment in the Build/Close Cost Matrix is associated a decision lead time. This is the estimated time from a decision to build a new resource until it is in production. For most resources, the decision lead time is 2 to 3 years. The investment lead time, the time when the investment for building the resource is effectively committed, is taken as half the investment lead time, or about a year in most cases.

One other factor in the handling of the investments should be noted at this point. Investments made late in the simulation have limited vehicles over which to amortize them. Consequently, investments made in the last four years are attenuated to account for this effect. Specifically, investments to be made in 1982, 1983, 1984 and 1985 are reduced 20%, 40%, 60% and 80%, respectively.

We are now in a position to transform the Incremental Resources Table into an Incremental Investment Table as is done by the incremental investment program. For a given resource starting in 1970, compare the incremental resources for the baseline and the test scenario. If these two numbers are the same (whether 0, +1 or -1), there is no incremental investment. If the number in the test scenario is +1 and the baseline is zero, we must invest in the prior year to build one resource. If the number in the test scenario is -1 and the baseline is 0, we will recover the "close" cost a year later. If the number in the test scenario is 0 and the baseline is +1, we have avoided building one resource and will recover that investment a year earlier. And, finally, if the number in the test scenario is 0 and the baseline is -1, we have failed to close a resource in the test scenario and will be penalized the amount of the close cost a year later. Proceeding in this fashion, we convert the Incremental Resources Needed file into a schedule of Incremental Investment Needed for the test scenario. This investment is then totalled by year for investment, investment recovered, and the net of these. The results are printed in the Yearly Investment Report, completing Step E.

Initially it was thought that investments could be evaluated without taking interest into consideration. Adding interest into the calculation brought sufficient realism to the study, particularly for economists, that it was considered worthwhile. The real interest rate (after removal of inflation) was taken as 4%.

The interest calculation was done in the following iterative way. Select a resource and find the net investment over the term of the scenario. Guess the total amount of interest over the scenario as a percentage of the total investment (an arbitrary initial choice of 5% was used based on experience). Starting with the year of first investment, add the principal outstanding at the end of the prior year (zero for the first year of investment) to the investment to be made in that year. Regard this amount as the average principal outstanding for the year and calculate the interest for the year at 4%. At the end of the year, add the average principal plus interest together and then decrease it by the investment recovered through sales for that year. The investment recovered by sales is simply the fraction of cars using this resource (the sales of cars using this resource this year divided by the total scenario sales using this resource) times the scenario total interest plus investment for this resource. This process is continued year by year through the scenario, until the final year's principal outstanding is found. This, of course, should be zero. If it is not, a new estimate is made of the total interest, and the process is repeated iteratively until the final principal outstanding is zero. The final interest is noted year by year for that resource, and the process is repeated for all resources. At the end, principal and interest are available year by year and resource by resource for that scenario, completing Step F.

The final Step G in Figure L1 is to apportion the investment costs and interest by the type of vehicle using the resource.[4] The purpose here is to determine the relative competitive position of different technologies.

In the assignment process, investment interest and investment (both positive and negative) are treated in an analogous fashion and so all will be referred to generically as investment expenditures in what follows. Select a resource and the first year of investment expenditure for that resource. Find the total number of cars being sold for the next three years which use that resource. Divide this number into the investment expenditure and get an average investment assessment per car. Tally the assessment year by year, and continue this process for all investment expenditures for that resource. The final result is an investment assessment which fluctuates from year to year, through the time frame of the scenario. Two summaries are then prepared. The first summary prepared is the sales weighted average of this investment assessment which is the average assessment per car and which might be assigned to recover the principal plus interest. The difficulty with this measure is that it assumes that future sales which will use this resource are as certain as near-term sales, a fact contrary to the experience of most businessmen. Consequently, a businessman's number is also reported, that being the maximum value of the investment assessment per car over the period 1975 to 1979. The assumption is that the assessment would be discontinued once the investment is recovered.

---

[4] It should be understood that this is an alternative way of summarizing investment to the yearly summary. The investment pattern for both, year by year and resource by resource, is the same.

Following this procedure, the interest and principal are calculated seperately and then the results are added. In the output reporter, these are titled "Interest," "Principal," and "Total." The maximum total investment assessment per car between 1975 and 1979 is titled "75-79 Max" in the output report.

In the computer program which does these calculations and generates these reports, all intermediate outputs are printed out for each run. This procedure greatly facilitates traceability of the changes induced in the scenario under test. For data control, each page of printout also contains a documentation line which lists explicitly all input files and programs used to create the data on that page. This procedure greatly reduces the possibility of sections of different computer runs being mistakenly collated together.

The output reports resulting from the application of these procedures to the 18 scenarios of Table F1 are presented in Appendix M.

APPENDIX M

Summary of Investment Cost Data

(Compiled by Merrill L. Ebner and LeRoy H. Lindgren)

In this appendix, the output data from the investment calculations described in Appendix L are presented. Table M1 presents the investment data by vehicle for 18 scenarios. A designation such as A/K indicates that A is the baseline scenario against which investments are being compared, and the K is the scenario being tested. The first part of the serial number is the vehicle number as defined in Table 3-2. Investment numbers are in 1974 dollars per vehicle. A minus sign indicates that a net investment recovery of the amount indicated has been credited to that car. The meanings of the various investment columns are defined in Appendix G.

Investments, over Scenario A, are summarized by year for 18 scenarios in Table M2. All figures are in thousands of 1974 dollars. A minus sign indicates a net investment recovery. The IN'T line indicates the sum of all investments which must be made (considered as positive investments). The RV'Y line indicates the sum of all investment recovered in that year (considered as negative investments). The NET line is simply the arithmetic sum of the IN'T and RV'Y values. Except of EXC and EXC-2, the values presented exclude any consideration of conversions (that is, only complete lines are built and closed as needed). The figures for EXC and ESC-2 do include a conversion investment taken as $15 million for each additional 350,000 units of sales volume (scenario volume) in CVCC cars.

TABLE M1

Summary of Investment Costs by Vehicle for the Various Scenarios

```
SERIAL NO.  VEHICLE DESCRIPTION                                                      PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 1 11111656  OC STD/CARB          MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX     -0.4647   -0.0386   -0.5033    0.0
 2 21112656  OC STD/CARB          SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX     -5.3127   -0.4041   -5.7168    0.0
 3 34113656  OC STD/CARB          COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX     -9.4364   -0.6048  -10.0412    0.0
 4 44115656  OC STD/CARB          INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX     -1.2187   -0.2781   -1.4968    0.0
 5 44116656  OC STD/CARB          INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX     -1.4523   -0.1162   -1.5685    0.0
 6 54117656  OC STD/CARB           STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX      5.9872    0.2997    6.2868    6.4826
 7 64118656  OC STD/CARB           LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX     -2.7132   -0.1695   -2.8827    0.0
 8 11111655  OC STD/CARB   AI/EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX      1.8634    0.1138    1.9772    3.0705
 9 21112655  OC STD/CARB   AI/EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX      1.8634    0.1138    1.9772    3.0705
10 34113655  OC STD/CARB   AI/EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX      1.8634    0.1138    1.9772    3.0705
11 44115655  OC STD/CARB   AI/EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX      1.8634    0.1138    1.9772    3.0705
12 44116655  OC STD/CARB   AI/EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX      1.8634    0.1138    1.9772    3.0705
13 54117655  OC STD/CARB   AI/EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX      1.8634    0.1138    1.9772    3.0705
14 64118655  OC STD/CARB   AI/EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX      1.8634    0.1138    1.9772    3.0705
15 11111655  OC STD/CARB      EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX      0.1111    0.0071    0.1182    0.2106
16 21112655  OC STD/CARB      EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX      0.1111    0.0071    0.1182    0.2106
17 34113655  OC STD/CARB      EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX      0.1111    0.0071    0.1182    0.2106
18 44115655  OC STD/CARB      EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX      0.2074    0.0142    0.2216    0.3548
19 44116655  OC STD/CARB      EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX      0.2074    0.0142    0.2216    0.3548
20 54117655  OC STD/CARB      EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX      0.2074    0.0142    0.2216    0.3548
21 64118655  OC STD/CARB      EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX      0.2074    0.0142    0.2216    0.3548
22 11111469  OC STD/CARB          MINI I4  90-CID M/TR 2.0HC 23CO  NRNOX     -0.4647   -0.0386   -0.5033    0.0
23 21112469  OC STD/CARB          SUBC I4 153-CID M/TR 2.0HC 23CO  NRNOX     -5.3127   -0.4041   -5.7168    0.0
24 34113469  OC STD/CARB          COMP I6 250-CID A/TR 2.0HC 23CO  NRNOX     -9.4364   -0.6048  -10.0412    0.0
25 44115469  OC STD/CARB          INTA V8 290-CID A/TR 2.0HC 23CO  NRNOX     -1.2187   -0.2781   -1.4968    0.0
26 44116469  OC STD/CARB          INTB V8 350-CID A/TR 2.0HC 23CO  NRNOX     -1.4523   -0.1162   -1.5685    0.0
27 54117469  OC STD/CARB           STD V8 400-CID A/TR 2.0HC 23CO  NRNOX      5.9872    0.2997    6.2868    6.4826
28 64118469  OC STD/CARB           LUX V8 500-CID A/TR 2.0HC 23CO  NRNOX     -2.7132   -0.1695   -2.8827    0.0
```

INVESTMENT SUMMARY
SCENARIO A/B

	SERIAL NO.	VEHICLE DESCRIPTION									PRINCIPAL	INTEREST	TOTAL	76-79 MAX
1	11111656	OC STD/CARB		MINI	I4	90-CID	M/TR	3.4HC	39CO	4.0NOX	-0.5112	-0.0285	-0.5398	-0.2625
2	21112656	OC STD/CARB		SUBC	I4	153-CID	M/TR	3.4HC	39CO	4.0NOX	-0.5112	-0.0331	-0.5444	-0.2625
3	34113656	OC STD/CARB		COMP	I6	250-CID	A/TR	3.4HC	39CO	4.0NOX	-0.6571	-0.0852	-0.7423	-0.2625
4	44115656	OC STD/CARB		INTA	V8	290-CID	A/TR	3.4HC	39CO	4.0NOX	-2.1985	-0.1326	-2.3312	-0.8572
5	44116656	OC STD/CARB		INTB	V8	350-CID	A/TR	3.4HC	39CO	4.0NOX	-0.6856	-0.0583	-0.7439	-0.8572
6	54117656	OC STD/CARB		STD	V8	400-CID	A/TR	3.4HC	39CO	4.0NOX	-1.7297	-0.1222	-1.8520	-0.8572
7	64118656	OC STD/CARB		LUX	V8	500-CID	A/TR	3.4HC	39CO	4.0NOX	-0.6856	-0.0583	-0.7439	-0.8572
8	11111655	OC STD/CARB	AI/EGR	MINI	I4	90-CID	M/TR	3.4HC	39CO	3.0NOX	0.6874	0.0684	0.7558	1.7929
9	21112655	OC STD/CARB	AI/EGR	SUBC	I4	153-CID	M/TR	3.4HC	39CO	3.0NOX	0.6874	0.0639	0.7512	1.7929
10	34113655	OC STD/CARB	AI/EGR	COMP	I6	250-CID	A/TR	3.4HC	39CO	3.0NOX	0.5415	0.0118	0.5533	1.7929
11	44115655	OC STD/CARB	AI/EGR	INTA	V8	290-CID	A/TR	3.4HC	39CO	3.0NOX	-0.9999	-0.0357	-1.0356	1.1983
12	44116655	OC STD/CARB	AI/EGR	INTB	V8	350-CID	A/TR	3.4HC	39CO	3.0NOX	0.5130	0.0387	0.5516	1.1983
13	54117655	OC STD/CARB	AI/EGR	STD	V8	400-CID	A/TR	3.4HC	39CO	3.0NOX	-0.5311	-0.0253	-0.5564	1.1983
14	64118655	OC STD/CARB	AI/EGR	LUX	V8	500-CID	A/TR	3.4HC	39CO	3.0NOX	0.5130	0.0387	0.5516	1.1983
15	11111655	OC STD/CARB	EGR	MINI	I4	90-CID	M/TR	3.4HC	39CO	3.0NOX	-0.4003	-0.0225	-0.4228	-0.1115
16	21112655	OC STD/CARB	EGR	SUBC	I4	153-CID	M/TR	3.4HC	39CO	3.0NOX	-0.4003	-0.0271	-0.4273	-0.1115
17	34113655	OC STD/CARB	EGR	COMP	I6	250-CID	A/TR	3.4HC	39CO	3.0NOX	-0.5461	-0.0791	-0.6252	-0.1115
18	44115655	OC STD/CARB	EGR	INTA	V8	290-CID	A/TR	3.4HC	39CO	3.0NOX	-1.9989	-0.1200	-2.1189	-0.5716
19	44116655	OC STD/CARB	EGR	INTB	V8	350-CID	A/TR	3.4HC	39CO	3.0NOX	-0.4859	-0.0457	-0.5316	-0.5716
20	54117655	OC STD/CARB	EGR	STD	V8	400-CID	A/TR	3.4HC	39CO	3.0NOX	-1.5301	-0.1096	-1.6397	-0.5716
21	64118655	OC STD/CARB	EGR	LUX	V8	500-CID	A/TR	3.4HC	39CO	3.0NOX	-0.4859	-0.0457	-0.5316	-0.5716
22	11111469	OC STD/CARB		MINI	I4	90-CID	M/TR	2.0HC	23CO	NRNOX	-0.5112	-0.0285	-0.5398	-0.2625
23	21112469	OC STD/CARB		SUBC	I4	153-CID	M/TR	2.0HC	23CO	NRNOX	-0.5112	-0.0331	-0.5444	-0.2625
24	34113469	OC STD/CARB		COMP	I6	250-CID	A/TR	2.0HC	23CO	NRNOX	-0.6571	-0.0852	-0.7423	-0.2625
25	44115469	OC STD/CARB		INTA	V8	290-CID	A/TR	2.0HC	23CO	NRNOX	-2.1985	-0.1326	-2.3312	-0.8572
26	44116469	OC STD/CARB		INTB	V8	350-CID	A/TR	2.0HC	23CO	NRNOX	-0.6056	-0.0583	-0.7439	-0.8572
27	54117469	OC STD/CARB		STD	V8	400-CID	A/TR	2.0HC	23CO	NRNOX	-1.7297	-0.1222	-1.8520	-0.8572
28	64118469	OC STD/CARB		LUX	V8	500-CID	A/TR	2.0HC	23CO	NRNOX	-0.6856	-0.0583	-0.7439	-0.8572
29	11121346	OC VEN/CARB	AI/DEGR	MINI	I4	90-CID	M/TR	1.5HC	15CO	3.1NOX	3.1774	0.1974	3.3747	2.3072
30	21122346	OC VEN/CARB	AI/DEGR	SUBC	I4	153-CID	M/TR	1.5HC	15CO	3.1NOX	3.1774	0.1928	3.3701	2.3072
31	34123346	OC VEN/CARB	AI/DEGR	COMP	I6	250-CID	A/TR	1.5HC	15CO	3.1NOX	3.0315	0.1407	3.1722	2.3072
32	44125346	OC VEN/CARB	AI/DEGR	INTA	V8	290-CID	A/TR	1.5HC	15CO	3.1NOX	1.6644	0.1231	1.7875	2.3072
33	44126346	OC VEN/CARB	AI/DEGR	INTB	V8	350-CID	A/TR	1.5HC	15CO	3.1NOX	2.8595	0.2326	3.0922	4.7691
34	54127346	OC VEN/CARB	AI/DEGR	STD	V8	400-CID	A/TR	1.5HC	15CO	3.1NOX	1.8154	0.1687	1.9841	4.7691
35	64128346	OC VEN/CARB	AI/DEGR	LUX	V8	500-CID	A/TR	1.5HC	15CO	3.1NOX	2.8595	0.2326	3.0922	4.7691
36	11121346	OC VEN/CARB	DEGR/HCAT	MINI	I4	90-CID	M/TR	1.5HC	15CO	3.1NOX	20.8936	1.2056	22.0993	21.2265
37	21122346	OC VEN/CARB	DEGR/HCAT	SUBC	I4	153-CID	M/TR	1.5HC	15CO	3.1NOX	20.8936	1.2010	22.0947	21.2265
38	34123346	OC VEN/CARB	DEGR/HCAT	COMP	I6	250-CID	A/TR	1.5HC	15CO	3.1NOX	20.7478	1.1490	21.8968	21.2265
39	44125346	OC VEN/CARB	DEGR/HCAT	INTA	V8	290-CID	A/TR	1.5HC	15CO	3.1NOX	19.3807	1.1313	20.5120	21.2265
40	44126346	OC VEN/CARB	DEGR/HCAT	INTB	V8	350-CID	A/TR	1.5HC	15CO	3.1NOX	8.1444	0.5394	8.6838	9.9283
41	54127346	OC VEN/CARB	DEGR/HCAT	STD	V8	400-CID	A/TR	1.5HC	15CO	3.1NOX	7.1002	0.4755	7.5757	9.9283

INVESTMENT SUMMARY
SCENARIO A/B'J'

```
 SERIAL NO.  VEHICLE DESCRIPTION                                                 PRINCIPAL  INTEREST     TOTAL  76-79 MAX

  42 64128346  OC VEN/CARB DEGR/HCAT   LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX       8.1444    0.5394     8.6838    9.9283
  43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0N      21.9813    1.2966    23.2778   23.1309
  44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0N      21.9813    1.2920    23.2732   23.1309
  45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0N      21.8354    1.2399    23.0753   23.1309
  46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0N      20.4683    1.2222    21.6906   23.1309
  47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0N       9.2320    0.6303     9.8623   11.8327
  48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0N       8.1879    0.5664     8.7543   11.8327
  49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0N       9.2320    0.6303     9.8623   11.8327
  50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO       22.2183    1.2924    23.5107   23.3809
  51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO       22.2183    1.2878    23.5061   23.3809
  52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO       22.0724    1.2358    23.3082   23.3809
  53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO       20.3875    1.2534    21.6409   25.8428
  54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO        9.4690    0.6262    10.0952   12.0827
  55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO        8.4249    0.5623     8.9872   12.0827
  56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO        9.4690    0.6262    10.0952   12.0827
  71 11121121  OC VEN/CARB AI/EFE/HNGCAT MINI I4 90 CID M/TR .4HC 3.4CO .4NO      39.5447    2.4003    41.9451   42.5589
  72 21122121  OC VEN/CARB AI/EFE/HNGCAT SUBC I4 153CID M/TR .4HC 3.4CO .4NO      39.5447    2.4003    41.9451   42.5589
  73 34123121  OC VEN/CARB AI/EFE/HNGCAT COMP I6 250CID A/TR .4HC 3.4CO .4NO      39.5447    2.4003    41.9451   42.5589
  74 44125121  OC VEN/CARB AI/EFE/HNGCAT INTA V8 290CID A/TR .4HC 3.4CO .4NO      39.2269    2.4356    41.6625   45.0208
  75 44126121  OC VEN/CARB AI/EFE/HNGCAT INTB V8 350CID A/TR .4HC 3.4CO .4NO      32.6360    2.1361    34.7721   37.7742
  76 54127121  OC VEN/CARB AI/EFE/HNGCAT STD  V8 400CID A/TR .4HC 3.4CO .4NO      32.6360    2.1361    34.7721   37.7742
  77 64128121  OC VEN/CARB AI/EFE/HNGCAT LUX  V8 500CID A/TR .4HC 3.4CO .4NO      32.6360    2.1361    34.7721   37.7742
 134 11141122  OC EFI/ECU   HNCCAT/O2 MINI I4  90-CID M/TR .4HC 3.4CO 1.0NOX      34.3613    1.6867    36.0480   50.4764
 135 21142122  OC EFI/ECU   HNCCAT/O2 SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NOX      34.3613    1.6821    36.0434   50.4764
 136 34143122  OC EFI/ECU   HNCCAT/O2 COMP I6 250-CID A/TR .4HC 3.4CO 1.0NOX      34.2154    1.6301    35.8455   50.4764
 137 44145122  OC EFI/ECU   HNCCAT/O2 INTA V8 290-CID A/TR .4HC 3.4CO 1.0NOX      32.8484    1.6124    34.4608   50.4764
 138 44146122  OC EFI/ECU   HNCCAT/O2 INTB V8 350-CID A/TR .4HC 3.4CO 1.0NOX      34.3613    1.6867    36.0480   50.4764
 139 54147122  OC EFI/ECU   HNCCAT/O2  STD V8 400-CID A/TR .4HC 3.4CO 1.0NOX      33.3172    1.6228    34.9400   50.4764
 140 64148122  OC EFI/ECU   HNCCAT/O2  LUX V8 500-CID A/TR .4HC 3.4CO 1.0NOX      34.3613    1.6867    36.0480   50.4764
 141 11141121 OC EFI/ECU AI/PEGR/HNCCAT/O2 MINI I4 90 CID M/TR .4HC 3.4CO .4      35.6860    1.7912    37.4772   52.6485
 142 21142121 OC EFI/ECU AI/PEGR/HNCCAT/O2 SUBC I4 153CID M/TR .4HC 3.4CO .4      35.6860    1.7866    37.4726   52.6485
 143 34143121 OC EFI/ECU AI/PEGR/HNCCAT/O2 COMP I6 250CID A/TR .4HC 3.4CO .4      35.5401    1.7346    37.2747   52.6485
 144 44145121 OC EFI/ECU AI/PEGR/HNCCAT/O2 INTA V8 290CID A/TR .4HC 3.4CO .4      34.1730    1.7169    35.8899   52.6485
 145 44146121 OC EFI/ECU AI/PEGR/HNCCAT/O2 INTB V8 350CID A/TR .4HC 3.4CO .4      35.5599    1.7837    37.3436   52.5319
 146 54147121 OC EFI/ECU AI/PEGR/HNCCAT/O2 STD  V8 400CID A/TR .4HC 3.4CO .4      34.5158    1.7198    36.2355   52.5319
 147 64148121 OC EFI/ECU AI/PEGR/HNCCAT/O2 LUX  V8 500CID A/TR .4HC 3.4CO .4      35.5599    1.7837    37.3436   52.5319



                                                                                                         INVESTMENT SUMMARY
                                                                                                         SCENARIO A/B'J'
```

```
SERIAL NO.  VEHICLE DESCRIPTION                                                      PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 1 11111656  OC STD/CARB             MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX    -0.3584   0.0        -0.3584    0.0
 2 21112656  OC STD/CARB             SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX    -0.3584   0.0        -0.3584    0.0
 3 34113656  OC STD/CARB             COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX    -0.3584   0.0        -0.3584    0.0
 4 44115656  OC STD/CARB             INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313   0.0        -2.0313    0.0
 5 44116656  OC STD/CARB             INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313   0.0        -2.0313    0.0
 6 54117656  OC STD/CARB              STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313   0.0        -2.0313    0.0
 7 64118656  OC STD/CARB              LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313   0.0        -2.0313    0.0
 8 11111655  OC STD/CARB      AI/EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     0.8710   0.0740      0.9450    2.0185
 9 21112655  OC STD/CARB      AI/EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     0.8710   0.0740      0.9450    2.0185
10 34113655  OC STD/CARB      AI/EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX     0.8710   0.0740      0.9450    2.0185
11 44115655  OC STD/CARB      AI/EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -0.8019   0.0740     -0.7278    2.0185
12 44116655  OC STD/CARB      AI/EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -0.8019   0.0740     -0.7278    2.0185
13 54117655  OC STD/CARB      AI/EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -0.8019   0.0740     -0.7278    2.0185
14 64118655  OC STD/CARB      AI/EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -0.8019   0.0740     -0.7278    2.0185
15 11111655  OC STD/CARB         EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX    -0.3584   0.0        -0.3584    0.0
16 21112655  OC STD/CARB         EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX    -0.3584   0.0        -0.3584    0.0
17 34113655  OC STD/CARB         EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX    -0.3584   0.0        -0.3584    0.0
18 44115655  OC STD/CARB         EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -1.9102   0.0073     -1.9030    0.1987
19 44116655  OC STD/CARB         EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -1.9102   0.0073     -1.9030    0.1987
20 54117655  OC STD/CARB         EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -1.9102   0.0073     -1.9030    0.1987
21 64118655  OC STD/CARB         EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -1.9102   0.0073     -1.9030    0.1987
22 11111469  OC STD/CARB             MINI I4  90-CID M/TR 2.0HC 23CO  NRNOX    -0.3584   0.0        -0.3584    0.0
23 21112469  OC STD/CARB             SUBC I4 153-CID M/TR 2.0HC 23CO  NRNOX    -0.3584   0.0        -0.3584    0.0
24 34113469  OC STD/CARB             COMP I6 250-CID A/TR 2.0HC 23CO  NRNOX    -0.3584   0.0        -0.3584    0.0
25 44115469  OC STD/CARB             INTA V8 290-CID A/TR 2.0HC 23CO  NRNOX    -2.0313   0.0        -2.0313    0.0
26 44116469  OC STD/CARB             INTB V8 350-CID A/TR 2.0HC 23CO  NRNOX    -2.0313   0.0        -2.0313    0.0
27 54117469  OC STD/CARB              STD V8 400-CID A/TR 2.0HC 23CO  NRNOX    -2.0313   0.0        -2.0313    0.0
28 64118469  OC STD/CARB              LUX V8 500-CID A/TR 2.0HC 23CO  NRNOX    -2.0313   0.0        -2.0313    0.0
29 11121346  OC VEN/CARB  AI/DEGR    MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     2.5698   0.1934      2.7631    3.9271
30 21122346  OC VEN/CARB  AI/DEGR    SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     2.5698   0.1934      2.7631    3.9271
31 34123346  OC VEN/CARB  AI/DEGR    COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX     2.5698   0.1934      2.7631    3.9271
32 44125346  OC VEN/CARB  AI/DEGR    INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     2.5698   0.1934      2.7631    3.9271
33 44126346  OC VEN/CARB  AI/DEGR    INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     2.3559   0.1725      2.5284    3.8452
34 54127346  OC VEN/CARB  AI/DEGR     STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX     2.3559   0.1725      2.5284    3.8452
35 64128346  OC VEN/CARB  AI/DEGR     LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX     2.3559   0.1725      2.5284    3.8452
36 11121346  OC VEN/CARB DEGR/HCAT   MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX    11.2687   0.7230     11.9917   17.9675
37 21122346  OC VEN/CARB DEGR/HCAT   SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX    11.2687   0.7230     11.9917   17.9675
38 34123346  OC VEN/CARB DEGR/HCAT   COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX    11.2687   0.7230     11.9917   17.9675
39 44125346  OC VEN/CARB DEGR/HCAT   INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX    11.2687   0.7230     11.9917   17.9675
40 44126346  OC VEN/CARB DEGR/HCAT   INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     4.1632   0.2832      4.4464    6.8144
41 54127346  OC VEN/CARB DEGR/HCAT    STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX     4.1632   0.2832      4.4464    6.8144

                                                                                                      INVESTMENT SUMMARY
                                                                                                      SCENARIO A/C
```

```
SERIAL NO.  VEHICLE DESCRIPTION                                                   PRINCIPAL  INTEREST     TOTAL 76-79 MAX

42 64128346  OC VEN/CARB DEGR/HCAT   LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX          4.1632    0.2832     4.4464    6.8144
43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX       12.4981    0.7971    13.2952   19.9860
44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX       12.4981    0.7971    13.2952   19.9860
45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX       12.4981    0.7971    13.2952   19.9860
46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX       12.4981    0.7971    13.2952   19.9860
47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX        5.3926    0.3573     5.7499    8.8329
48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX        5.3926    0.3573     5.7499    8.8329
49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX        5.3926    0.3573     5.7499    8.8329
50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.       12.8632    0.8138    13.6771   20.3047
51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.       12.8632    0.8138    13.6771   20.3047
52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.       12.8632    0.8138    13.6771   20.3047
53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.       12.6494    0.7930    13.4424   20.2227
54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.        5.7577    0.3741     6.1318    9.1516
55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO 2.        5.7577    0.3741     6.1318    9.1516
56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.        5.7577    0.3741     6.1318    9.1516
```

INVESTMENT SUMMARY
SCENARIO A/C

```
SERIAL NO.  VEHICLE DESCRIPTION                                                            PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 1 11111656  OC STD/CARB              MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX    -0.3592    0.0       -0.3592   0.0
 2 21112656  OC STD/CARB              SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX    -0.3592   -0.0045    -0.3638   0.0
 3 34113656  OC STD/CARB              COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX    -0.5051   -0.0567    -0.5618   0.0
 4 44115656  OC STD/CARB              INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX    -3.5481   -0.0743    -3.6224   0.0
 5 44116656  OC STD/CARB              INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX    -2.0349    0.0       -2.0349   0.0
 6 54117656  OC STD/CARB               STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX    -3.0786   -0.0639    -3.1425   0.0
 7 64118656  OC STD/CARB               LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX    -2.0349    0.0       -2.0349   0.0
 8 11111655  OC STD/CARB       AI/EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     1.2361    0.1288     1.3649   5.0187
 9 21112655  OC STD/CARB       AI/EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     1.2361    0.1242     1.3603   5.0187
10 34113655  OC STD/CARB       AI/EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX     1.0902    0.0721     1.1623   5.0187
11 44115655  OC STD/CARB       AI/EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -1.9528    0.0545    -1.8983   5.0187
12 44116655  OC STD/CARB       AI/EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -0.4396    0.1288    -0.3108   5.0187
13 54117655  OC STD/CARB       AI/EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -1.4833    0.0649    -1.4184   5.0187
14 64118655  OC STD/CARB       AI/EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -0.4396    0.1288    -0.3108   5.0187
15 11111655  OC STD/CARB          EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     0.1680    0.0493     0.2173   3.3869
16 21112655  OC STD/CARB          EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     0.1680    0.0448     0.2128   3.3869
17 34113655  OC STD/CARB          EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX     0.0221   -0.0073     0.0148   3.3869
18 44115655  OC STD/CARB          EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -2.9157   -0.0172    -2.9329   3.5475
19 44116655  OC STD/CARB          EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -1.4025    0.0572    -1.3454   3.5475
20 54117655  OC STD/CARB          EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -2.4462   -0.0067    -2.4530   3.5475
21 64118655  OC STD/CARB          EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -1.4025    0.0572    -1.3454   3.5475
22 11111469  OC STD/CARB              MINI I4  90-CID M/TR 2.0HC 23CO  NRNOX    -0.3592    0.0       -0.3592   0.0
23 21112469  OC STD/CARB              SUBC I4 153-CID M/TR 2.0HC 23CO  NRNOX    -0.3592   -0.0045    -0.3638   0.0
24 34113469  OC STD/CARB              COMP I6 250-CID A/TR 2.0HC 23CO  NRNOX    -0.5051   -0.0567    -0.5618   0.0
25 44115469  OC STD/CARB              INTA V8 290-CID A/TR 2.0HC 23CO  NRNOX    -3.5481   -0.0743    -3.6224   0.0
26 44116469  OC STD/CARB              INTB V8 350-CID A/TR 2.0HC 23CO  NRNOX    -2.0349    0.0       -2.0349   0.0
27 54117469  OC STD/CARB               STD V8 400-CID A/TR 2.0HC 23CO  NRNOX    -3.0786   -0.0639    -3.1425   0.0
28 64118469  OC STD/CARB               LUX V8 500-CID A/TR 2.0HC 23CO  NRNOX    -2.0349    0.0       -2.0349   0.0
29 11121346  OC VEN/CARB   AI/DEGR    MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     2.3400    0.1936     2.5336   3.6563
30 21122346  OC VEN/CARB   AI/DEGR    SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     2.3400    0.1891     2.5291   3.6563
31 34123346  OC VEN/CARB   AI/DEGR    COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX     2.1941    0.1370     2.3311   3.6563
32 44125346  OC VEN/CARB   AI/DEGR    INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     0.8268    0.1193     0.9461   3.6563
33 44126346  OC VEN/CARB   AI/DEGR    INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     2.3948    0.1988     2.5936   3.9695
34 54127346  OC VEN/CARB   AI/DEGR     STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX     1.3511    0.1349     1.4860   3.9695
35 64128346  OC VEN/CARB   AI/DEGR     LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX     2.3948    0.1988     2.5936   3.9695
36 11121346  OC VEN/CARB DEGR/HCAT    MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX    10.6674    0.7167    11.3841  17.4818
37 21122346  OC VEN/CARB DEGR/HCAT    SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX    10.6674    0.7122    11.3796  17.4818
38 34123346  OC VEN/CARB DEGR/HCAT    COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX    10.5215    0.6601    11.1816  17.4818
39 44125346  OC VEN/CARB DEGR/HCAT    INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     9.1541    0.6424     9.7966  17.4818
40 44126346  OC VEN/CARB DEGR/HCAT    INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     4.5113    0.3232     4.8345   7.5584
41 54127346  OC VEN/CARB DEGR/HCAT     STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX     3.4675    0.2593     3.7269   7.5584

                                                                                                          INVESTMENT SUMMARY
                                                                                                          SCENARIO A/C'J'
 SERIAL NO.  VEHICLE DESCRIPTION                                                PRINCIPAL  INTEREST     TOTAL 76-79 MAX

  42 64128346  OC VEN/CARB DEGR/HCAT   LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX      4.5113    0.3232     4.8345    7.5584
  43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0N     11.7355    0.7962    12.5317   19.1136
  44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0N     11.7355    0.7917    12.5271   19.1136
  45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0N     11.5896    0.7395    12.3291   19.1136
  46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0N     10.2223    0.7219    10.9441   19.1136
  47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0N      5.5794    0.4027     5.9821    9.1902
  48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0N      4.5357    0.3388     4.8744    9.1902
  49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0N      5.5794    0.4027     5.9821    9.1902
  50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO      11.8541    0.8030    12.6570   19.2289
  51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO      11.8541    0.7984    12.6525   19.2289
  52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO      11.7082    0.7463    12.4545   19.2289
  53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO      10.3956    0.7338    11.1295   19.5421
  54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO       5.6980    0.4094     6.1074    9.3055
  55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO       4.6543    0.3456     4.9998    9.3055
  56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO       5.6980    0.4094     6.1074    9.3055
  71 11121121  OC VEN/CARB AI/EFE/HNGCAT MINI I4 90 CID M/TR .4HC 3.4CO .4NO     29.2361    1.9142    31.1504   38.4715
  72 21122121  OC VEN/CARB AI/EFE/HNGCAT SUBC I4 153CID M/TR .4HC 3.4CO .4NO     29.2361    1.9142    31.1504   38.4715
  73 34123121  OC VEN/CARB AI/EFE/HNGCAT COMP I6 250CID A/TR .4HC 3.4CO .4NO     29.2361    1.9142    31.1504   38.4715
  74 44125121  OC VEN/CARB AI/EFE/HNGCAT INTA V8 290CID A/TR .4HC 3.4CO .4NO     29.2909    1.9194    31.2103   38.7847
  75 44126121  OC VEN/CARB AI/EFE/HNGCAT INTB V8 350CID A/TR .4HC 3.4CO .4NO     25.8861    1.7665    27.6526   33.6665
  76 54127121  OC VEN/CARB AI/EFE/HNGCAT STD  V8 400CID A/TR .4HC 3.4CO .4NO     25.8861    1.7665    27.6526   33.6665
  77 64128121  OC VEN/CARB AI/EFE/HNGCAT LUX  V8 500CID A/TR .4HC 3.4CO .4NO     25.8861    1.7665    27.6526   33.6665
 134 11141122  OC EFI/ECU   HNCCAT/O2 MINI I4  90-CID M/TR .4HC 3.4CO 1.0NOX     34.3344    1.6905    36.0249   50.4921
 135 21142122  OC EFI/ECU   HNCCAT/O2 SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NOX     34.3344    1.6860    36.0204   50.4921
 136 34143122  OC EFI/ECU   HNCCAT/O2 COMP I6 250-CID A/TR .4HC 3.4CO 1.0NOX     34.1885    1.6339    35.8224   50.4921
 137 44145122  OC EFI/ECU   HNCCAT/O2 INTA V8 290-CID A/TR .4HC 3.4CO 1.0NOX     32.8212    1.6162    34.4374   50.4921
 138 44146122  OC EFI/ECU   HNCCAT/O2 INTB V8 350-CID A/TR .4HC 3.4CO 1.0NOX     34.3344    1.6905    36.0249   50.4921
 139 54147122  OC EFI/ECU   HNCCAT/O2  STD V8 400-CID A/TR .4HC 3.4CO 1.0NOX     33.2907    1.6266    34.9173   50.4921
 140 64148122  OC EFI/ECU   HNCCAT/O2  LUX V8 500-CID A/TR .4HC 3.4CO 1.0NOX     34.3344    1.6905    36.0249   50.4921
 141 11141121 OC EFI/ECU AI/PEGR/HNCCAT/O2 MINI I4 90 CID M/TR .4HC 3.4CO .4     35.5839    1.7812    37.3641   52.3270
 142 21142121 OC EFI/ECU AI/PEGR/HNCCAT/O2 SUBC I4 153CID M/TR .4HC 3.4CO .4     35.5839    1.7757    37.3596   52.3270
 143 34143121 OC EFI/ECU AI/PEGR/HNCCAT/O2 COMP I6 250CID A/TR .4HC 3.4CO .4     35.4380    1.7235    37.1616   52.3270
 144 44145121 OC EFI/ECU AI/PEGR/HNCCAT/O2 INTA V8 290CID A/TR .4HC 3.4CO .4     34.0707    1.7059    35.7766   52.3270
 145 44146121 OC EFI/ECU AI/PEGR/HNCCAT/O2 INTB V8 350CID A/TR .4HC 3.4CO .4     35.9297    1.8193    37.7490   55.5107
 146 54147121 OC EFI/ECU AI/PEGR/HNCCAT/O2 STD  V8 400CID A/TR .4HC 3.4CO .4     34.8860    1.7554    36.6414   55.5107
 147 64148121 OC EFI/ECU AI/PEGR/HNCCAT/O2 LUX  V8 500CID A/TR .4HC 3.4CO .4     35.9297    1.8193    37.7490   55.5107
```

INVESTMENT SUMMARY
SCENARIO A/C'J'

	SERIAL NO.	VEHICLE DESCRIPTION	PRINCIPAL	INTEREST	TOTAL	76-79 MAX
1	11111656	OC STD/CARB MINI I4 90-CID M/TR 3.4HC 39CO 4.0NOX	76.5063	3.9460	80.4523	82.8356
2	21112656	OC STD/CARB SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX	29.4131	2.5610	31.9741	46.1390
3	34113656	OC STD/CARB COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX	35.9222	2.9980	38.9202	36.8878
4	44115656	OC STD/CARB INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX	11.0822	0.9842	12.0665	14.3501
5	44116656	OC STD/CARB INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX	-18.3562	-1.2420	-19.5982	0.0
6	54117656	OC STD/CARB STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX	-142.0713	-11.4900	-153.5613	-1.1676
7	64118656	OC STD/CARB LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX	-14.1983	-0.6758	-14.8740	0.0
8	11111655	OC STD/CARB AI/EGR MINI I4 90-CID M/TR 3.4HC 39CO 3.0NOX	77.8543	4.0279	81.8821	85.0038
9	21112655	OC STD/CARB AI/EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX	30.7611	2.6428	33.4039	48.3072
10	34113655	OC STD/CARB AI/EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX	37.2701	3.0799	40.3500	39.0560
11	44115655	OC STD/CARB AI/EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX	12.4302	1.0661	13.4963	16.5183
12	44116655	OC STD/CARB AI/EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX	-17.0082	-1.1601	-18.1683	2.1682
13	54117655	OC STD/CARB AI/EGR STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX	-140.7233	-11.4081	-152.1314	1.0006
14	64118655	OC STD/CARB AI/EGR LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX	-12.8503	-0.5939	-13.4442	2.1682
15	11111655	OC STD/CARB EGR MINI I4 90-CID M/TR 3.4HC 39CO 3.0NOX	76.5063	3.9460	80.4523	82.8356
16	21112655	OC STD/CARB EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX	29.4131	2.5610	31.9741	46.1390
17	34113655	OC STD/CARB EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX	35.9222	2.9980	38.9202	36.8878
18	44115655	OC STD/CARB EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX	11.2387	0.9932	12.2319	14.5655
19	44116655	OC STD/CARB EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX	-18.1997	-1.2331	-19.4327	0.2153
20	54117655	OC STD/CARB EGR STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX	-141.9148	-11.4811	-153.3959	-0.9523
21	64118655	OC STD/CARB EGR LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX	-14.0418	-0.6668	-14.7086	0.2153
22	11111469	OC STD/CARB MINI I4 90-CID M/TR 2.0HC 23CO NRNOX	76.5063	3.9460	80.4523	82.8356
23	21112469	OC STD/CARB SUBC I4 153-CID M/TR 2.0HC 23CO NRNOX	29.4131	2.5610	31.9741	46.1390
24	34113469	OC STD/CARB COMP I6 250-CID A/TR 2.0HC 23CO NRNOX	35.9222	2.9980	38.9202	36.8878
25	44115469	OC STD/CARB INTA V8 290-CID A/TR 2.0HC 23CO NRNOX	11.0822	0.9842	12.0665	14.3501
26	44116469	OC STD/CARB INTB V8 350-CID A/TR 2.0HC 23CO NRNOX	-18.3562	-1.2420	-19.5982	0.0
27	54117469	OC STD/CARB STD V8 400-CID A/TR 2.0HC 23CO NRNOX	-142.0713	-11.4900	-153.5613	-1.1676
28	64118469	OC STD/CARB LUX V8 500-CID A/TR 2.0HC 23CO NRNOX	-14.1983	-0.6758	-14.8740	0.0
29	11121346	OC VEN/CARB AI/DEGR MINI I4 90-CID M/TR 1.5HC 15CO 3.1NOX	79.8208	4.1737	83.9946	87.3122
30	21122346	OC VEN/CARB AI/DEGR SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX	32.7277	2.7887	35.5164	50.6155
31	34123346	OC VEN/CARB AI/DEGR COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX	39.2367	3.2257	42.4624	41.3644
32	44125346	OC VEN/CARB AI/DEGR INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX	16.0690	1.2120	17.2809	18.8267
33	44126346	OC VEN/CARB AI/DEGR INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX	-13.3742	-1.0230	-14.3972	4.7463
34	54127346	OC VEN/CARB AI/DEGR STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX	-137.0893	-11.2710	-148.3603	3.5787
35	64128346	OC VEN/CARB AI/DEGR LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX	-9.2163	-0.4567	-9.6730	4.7463
36	11121346	OC VEN/CARB DEGR/HCAT MINI I4 90-CID M/TR 1.5HC 15CO 3.1NOX	85.1458	4.6508	89.7966	98.3633
37	21122346	OC VEN/CARB DEGR/HCAT SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX	38.0526	3.2658	41.3184	61.6666
38	34123346	OC VEN/CARB DEGR/HCAT COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX	44.5617	3.7028	48.2645	52.4155
39	44125346	OC VEN/CARB DEGR/HCAT INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX	21.3939	1.6890	23.0830	29.8778
40	44126346	OC VEN/CARB DEGR/HCAT INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX	-10.6220	-0.8275	-11.4495	9.4335
41	54127346	OC VEN/CARB DEGR/HCAT STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX	-134.3371	-11.0755	-145.4126	8.2659

INVESTMENT SUMMARY
SCENARIO A/CSV

```
SERIAL NO.  VEHICLE DESCRIPTION                                                   PRINCIPAL  INTEREST     TOTAL  76-79 MAX

42 64128346  OC VEN/CARB DEGR/HCAT    LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX      -6.4641   -0.2612   -6.7253     9.4335
43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX     86.4938    4.7327   91.2265   100.5314
44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX     39.4006    3.3476   42.7482    63.8348
45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX     45.9997    3.7846   49.6943    54.5836
46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX     22.7419    1.7709   24.5128    32.0459
47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX     -9.2740   -0.7456  -10.0196    11.6017
48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX   -132.9891  -10.9936 -143.9827    10.4341
49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX     -5.1161   -0.1794   -5.2955    11.6017
50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.     86.8783    4.7508   91.6291   100.8721
51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.     39.7851    3.3658   43.1509    64.1754
52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.     46.2941    3.8028   50.0970    54.9243
53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.     23.1216    1.7804   24.9020    32.6562
54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.     -8.8896   -0.7274   -9.6170    11.9423
55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO 2.   -132.6047  -10.9754 -143.5801    10.7747
56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.     -4.7317   -0.1612   -4.8928    11.9423
```

INVESTMENT SUMMARY
SCENARIO A/CSV

```
SERIAL NO.  VEHICLE DESCRIPTION                                                         PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 1 11111656  OC STD/CARB             MINI I4  90-CID M/TR 3.4HC  39CO 4.0NOX     -0.3584    0.0        -0.3584    0.0
 2 21112656  OC STD/CARB             SUBC I4 153-CID M/TR 3.4HC  39CO 4.0NOX     -0.3584    0.0        -0.3584    0.0
 3 34113656  OC STD/CARB             COMP I6 250-CID A/TR 3.4HC  39CO 4.0NOX     -0.3584    0.0        -0.3584    0.0
 4 44115656  OC STD/CARB             INTA V8 290-CID A/TR 3.4HC  39CO 4.0NOX     -2.0313    0.0        -2.0313    0.0
 5 44116656  OC STD/CARB             INTB V8 350-CID A/TR 3.4HC  39CO 4.0NOX     -2.0313    0.0        -2.0313    0.0
 6 54117656  OC STD/CARB              STD V8 400-CID A/TR 3.4HC  39CO 4.0NOX     -2.0313    0.0        -2.0313    0.0
 7 64118656  OC STD/CARB              LUX V8 500-CID A/TR 3.4HC  39CO 4.0NOX     -2.0313    0.0        -2.0313    0.0
 8 11111655  OC STD/CARB      AI/EGR MINI I4  90-CID M/TR 3.4HC  39CO 3.0NOX      0.4979    0.0794      0.5773    1.3048
 9 21112655  OC STD/CARB      AI/EGR SUBC I4 153-CID M/TR 3.4HC  39CO 3.0NOX      0.4979    0.0794      0.5773    1.3048
10 34113655  OC STD/CARB      AI/EGR COMP I6 250-CID A/TR 3.4HC  39CO 3.0NOX      0.4979    0.0794      0.5773    1.3048
11 44115655  OC STD/CARB      AI/EGR INTA V8 290-CID A/TR 3.4HC  39CO 3.0NOX     -1.1750    0.0794     -1.0956    1.3048
12 44116655  OC STD/CARB      AI/EGR INTB V8 350-CID A/TR 3.4HC  39CO 3.0NOX     -1.1750    0.0794     -1.0956    1.3048
13 54117655  OC STD/CARB      AI/EGR  STD V8 400-CID A/TR 3.4HC  39CO 3.0NOX     -1.1750    0.0794     -1.0956    1.3048
14 64118655  OC STD/CARB      AI/EGR  LUX V8 500-CID A/TR 3.4HC  39CO 3.0NOX     -1.1750    0.0794     -1.0956    1.3048
15 11111655  OC STD/CARB         EGR MINI I4  90-CID M/TR 3.4HC  39CO 3.0NOX     -0.3584    0.0        -0.3584    0.0
16 21112655  OC STD/CARB         EGR SUBC I4 153-CID M/TR 3.4HC  39CO 3.0NOX     -0.3584    0.0        -0.3584    0.0
17 34113655  OC STD/CARB         EGR COMP I6 250-CID A/TR 3.4HC  39CO 3.0NOX     -0.3584    0.0        -0.3584    0.0
18 44115655  OC STD/CARB         EGR INTA V8 290-CID A/TR 3.4HC  39CO 3.0NOX     -1.9470    0.0078     -1.9392    0.1285
19 44116655  OC STD/CARB         EGR INTB V8 350-CID A/TR 3.4HC  39CO 3.0NOX     -1.9470    0.0078     -1.9392    0.1285
20 54117655  OC STD/CARB         EGR  STD V8 400-CID A/TR 3.4HC  39CO 3.0NOX     -1.9470    0.0078     -1.9392    0.1285
21 64118655  OC STD/CARB         EGR  LUX V8 500-CID A/TR 3.4HC  39CO 3.0NOX     -1.9470    0.0078     -1.9392    0.1285
22 11111469  OC STD/CARB             MINI I4  90-CID M/TR 2.0HC  23CO  NRNOX     -0.3584    0.0        -0.3584    0.0
23 21112469  OC STD/CARB             SUBC I4 153-CID M/TR 2.0HC  23CO  NRNOX     -0.3584    0.0        -0.3584    0.0
24 34113469  OC STD/CARB             COMP I6 250-CID A/TR 2.0HC  23CO  NRNOX     -0.3584    0.0        -0.3584    0.0
25 44115469  OC STD/CARB             INTA V8 290-CID A/TR 2.0HC  23CO  NRNOX     -2.0313    0.0        -2.0313    0.0
26 44116469  OC STD/CARB             INTB V8 350-CID A/TR 2.0HC  23CO  NRNOX     -2.0313    0.0        -2.0313    0.0
27 54117469  OC STD/CARB              STD V8 400-CID A/TR 2.0HC  23CO  NRNOX     -2.0313    0.0        -2.0313    0.0
28 64118469  OC STD/CARB              LUX V8 500-CID A/TR 2.0HC  23CO  NRNOX     -2.0313    0.0        -2.0313    0.0
29 11121346  OC VEN/CARB  AI/DEGR    MINI I4  90-CID M/TR 1.5HC  15CO 3.1NOX      2.4028    0.2180      2.6208    3.5540
30 21122346  OC VEN/CARB  AI/DEGR    SUBC I4 153-CID M/TR 1.5HC  15CO 3.1NOX      2.4028    0.2180      2.6208    3.5540
31 34123346  OC VEN/CARB  AI/DEGR    COMP I6 250-CID A/TR 1.5HC  15CO 3.1NOX      2.4028    0.2180      2.6208    3.5540
32 44125346  OC VEN/CARB  AI/DEGR    INTA V8 290-CID A/TR 1.5HC  15CO 3.1NOX      2.4028    0.2180      2.6208    3.5540
33 44126346  OC VEN/CARB  AI/DEGR    INTB V8 350-CID A/TR 1.5HC  15CO 3.1NOX      2.3571    0.2206      2.5777    4.1776
34 54127346  OC VEN/CARB  AI/DEGR     STD V8 400-CID A/TR 1.5HC  15CO 3.1NOX      2.3571    0.2206      2.5777    4.1776
35 64128346  OC VEN/CARB  AI/DEGR     LUX V8 500-CID A/TR 1.5HC  15CO 3.1NOX      2.3571    0.2206      2.5777    4.1776
36 11121345  OC VEN/CARB DEGR/HCAT   MINI I4  90-CID M/TR 1.5HC  15CO 3.1NOX     10.8396    0.7043     11.5439   17.2739
37 21122346  OC VEN/CARB DEGR/HCAT   SUBC I4 153-CID M/TR 1.5HC  15CO 3.1NOX     10.8396    0.7043     11.5439   17.2739
38 34123346  OC VEN/CARB DEGR/HCAT   COMP I6 250-CID A/TR 1.5HC  15CO 3.1NOX     10.8396    0.7043     11.5439   17.2739
39 44125346  OC VEN/CARB DEGR/HCAT   INTA V8 290-CID A/TR 1.5HC  15CO 3.1NOX     10.8396    0.7043     11.5439   17.2739
40 44126346  OC VEN/CARB DEGR/HCAT   INTB V8 350-CID A/TR 1.5HC  15CO 3.1NOX      4.5359    0.3259      4.8617    7.8574
41 54127346  OC VEN/CARB DEGR/HCAT    STD V8 400-CID A/TR 1.5HC  15CO 3.1NOX      4.5359    0.3259      4.8617    7.8574

                                                                                                                INVESTMENT SUMMARY
                                                                                                                SCENARIO A/E
```

```
    SERIAL NO.  VEHICLE DESCRIPTION                                                    PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 42 64128346  OC VEN/CARB DEGR/HCAT   LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX            4.5359     0.3259    4.8617    7.8574
 43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX         11.6959     0.7837   12.4796   18.5787
 44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX         11.6959     0.7837   12.4796   18.5787
 45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX         11.6959     0.7837   12.4796   18.5787
 46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX         11.6959     0.7837   12.4796   18.5787
 47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX          5.3922     0.4052    5.7974    9.1622
 48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX          5.3922     0.4052    5.7974    9.1622
 49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX          5.3922     0.4052    5.7974    9.1622
 50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.         11.8491     0.7906   12.6397   18.8777
 51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.         11.8491     0.7906   12.6397   18.8777
 52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.         11.8491     0.7906   12.6397   18.8777
 53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.         11.8034     0.7932   12.5966   19.5013
 54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.          5.5454     0.4122    5.9576    9.4612
 55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO 2.          5.5454     0.4122    5.9576    9.4612
 56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.          5.5454     0.4122    5.9576    9.4612
134 11141122  OC EFI/ECU   HNCCAT/O2 MINI I4  90-CID M/TR .4HC 3.4CO 1.0NOX           37.1766     2.0881   39.2648   45.0166
135 21142122  OC EFI/ECU   HNCCAT/O2 SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NOX           37.1766     2.0881   39.2648   45.0166
136 34143122  OC EFI/ECU   HNCCAT/O2 COMP I6 250-CID A/TR .4HC 3.4CO 1.0NOX           37.1766     2.0881   39.2648   45.0166
137 44145122  OC EFI/ECU   HNCCAT/O2 INTA V8 290-CID A/TR .4HC 3.4CO 1.0NOX           37.1766     2.0881   39.2648   45.0166
138 44146122  OC EFI/ECU   HNCCAT/O2 INTB V8 350-CID A/TR .4HC 3.4CO 1.0NOX           37.1766     2.0881   39.2648   45.0166
139 54147122  OC EFI/ECU   HNCCAT/O2  STD V8 400-CID A/TR .4HC 3.4CO 1.0NOX           37.1766     2.0881   39.2648   45.0166
140 64148122  OC EFI/ECU   HNCCAT/O2  LUX V8 500-CID A/TR .4HC 3.4CO 1.0NOX           37.1766     2.0881   39.2648   45.0166
```

INVESTMENT SUMMARY
SCENARIO A/E

```
SERIAL NO.  VEHICLE DESCRIPTION                                                 PRINCIPAL  INTEREST    TOTAL 76-79 MAX

 1 11111656   OC STD/CARB               MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX   -0.3584    0.0      -0.3584    0.0
 2 21112656   OC STD/CARB               SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX   -0.3584    0.0      -0.3584    0.0
 3 34113656   OC STD/CARB               COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX   -0.3584    0.0      -0.3584    0.0
 4 44115656   OC STD/CARB               INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX   -2.0313    0.0      -2.0313    0.0
 5 44116656   OC STD/CARB               INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX   -2.0313    0.0      -2.0313    0.0
 6 54117656   OC STD/CARB                STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX   -2.0313    0.0      -2.0313    0.0
 7 64118656   OC STD/CARB                LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX   -2.0313    0.0      -2.0313    0.0
 8 11111655   OC STD/CARB        AI/EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX    0.4333    0.0738    0.5071    1.2187
 9 21112655   OC STD/CARB        AI/EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX    0.4333    0.0738    0.5071    1.2187
10 34113655   OC STD/CARB        AI/EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX    0.4333    0.0738    0.5071    1.2187
11 44115655   OC STD/CARB        AI/EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX   -1.2396    0.0738   -1.1658    1.2187
12 44115655   OC STD/CARB        AI/EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX   -1.2396    0.0738   -1.1658    1.2187
13 54117655   OC STD/CARB        AI/EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX   -1.2396    0.0738   -1.1658    1.2187
14 64118655   OC STD/CARB        AI/EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX   -1.2396    0.0738   -1.1658    1.2187
15 11111655   OC STD/CARB           EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX   -0.3584    0.0      -0.3584    0.0
16 21112655   OC STD/CARB           EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX   -0.3584    0.0      -0.3584    0.0
17 34113655   OC STD/CARB           EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX   -0.3584    0.0      -0.3584    0.0
18 44115655   OC STD/CARB           EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX   -1.9533    0.0073   -1.9461    0.1200
19 44116655   OC STD/CARB           EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX   -1.9533    0.0073   -1.9461    0.1200
20 54117655   OC STD/CARB           EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX   -1.9533    0.0073   -1.9461    0.1200
21 64118655   OC STD/CARB           EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX   -1.9533    0.0073   -1.9461    0.1200
22 11111469   OC STD/CARB               MINI I4  90-CID M/TR 2.0HC 23CO  NRNOX   -0.3584    0.0      -0.3584    0.0
23 21112469   OC STD/CARB               SUBC I4 153-CID M/TR 2.0HC 23CO  NRNOX   -0.3584    0.0      -0.3584    0.0
24 34113469   OC STD/CARB               COMP I6 250-CID A/TR 2.0HC 23CO  NRNOX   -0.3584    0.0      -0.3584    0.0
25 44115469   OC STD/CARB               INTA V8 290-CID A/TR 2.0HC 23CO  NRNOX   -2.0313    0.0      -2.0313    0.0
26 44116469   OC STD/CARB               INTB V8 350-CID A/TR 2.0HC 23CO  NRNOX   -2.0313    0.0      -2.0313    0.0
27 54117469   OC STD/CARB                STD V8 400-CID A/TR 2.0HC 23CO  NRNOX   -2.0313    0.0      -2.0313    0.0
28 64118469   OC STD/CARB                LUX V8 500-CID A/TR 2.0HC 23CO  NRNOX   -2.0313    0.0      -2.0313    0.0
29 11121346   OC VEN/CARB   AI/DEGR     MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX    2.2079    0.2056    2.4134    3.5399
30 21122346   OC VEN/CARB   AI/DEGR     SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX    2.2079    0.2056    2.4134    3.5399
31 34123346   OC VEN/CARB   AI/DEGR     COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX    2.2079    0.2056    2.4134    3.5399
32 44125346   OC VEN/CARB   AI/DEGR     INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX    2.2079    0.2056    2.4134    3.5399
33 44126346   OC VEN/CARB   AI/DEGR     INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX    2.2925    0.2150    2.5075    4.0915
34 54127346   OC VEN/CARB   AI/DEGR      STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX    2.2925    0.2150    2.5075    4.0915
35 64128346   OC VEN/CARB   AI/DEGR      LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX    2.2925    0.2150    2.5075    4.0915
36 11121346   OC VEN/CARB DEGR/HCAT     MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX    8.7024    0.6906    9.3930   15.9565
37 21122346   OC VEN/CARB DEGR/HCAT     SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX    8.7024    0.6906    9.3930   15.9565
38 34123346   OC VEN/CARB DEGR/HCAT     COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX    8.7024    0.6906    9.3930   15.9565
39 44125346   OC VEN/CARB DEGR/HCAT     INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX    8.7024    0.6906    9.3930   15.9565
40 44126346   OC VEN/CARB DEGR/HCAT     INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX    4.5359    0.3259    4.8617    7.8574
41 54127346   OC VEN/CARB DEGR/HCAT      STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX    4.5359    0.3259    4.8617    7.8574

                                                                                                     INVESTMENT SUMMARY
                                                                                                     SCENARIO A/E-2
```

```
SERIAL NO.  VEHICLE DESCRIPTION                                                PRINCIPAL  INTEREST     TOTAL 76-79 MAX

42 64128346  OC VEN/CARB DEGR/HCAT   LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX       4.5359    0.3259     4.8617    7.8574
43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX     9.4941    0.7644    10.2585   17.1752
44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX     9.4941    0.7644    10.2585   17.1752
45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX     9.4941    0.7644    10.2585   17.1752
46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX     9.4941    0.7644    10.2585   17.1752
47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX     5.3276    0.3997     5.7272    9.0761
48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX     5.3276    0.3997     5.7272    9.0761
49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX     5.3276    0.3997     5.7272    9.0761
50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.     9.6724    0.7702    10.4426   17.4536
51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.     9.6724    0.7702    10.4426   17.4536
52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.     9.6724    0.7702    10.4426   17.4536
53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.     9.7571    0.7796    10.5367   18.0051
54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.     5.5058    0.4055     5.9113    9.3544
55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO 2.     5.5058    0.4055     5.9113    9.3544
56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.     5.5058    0.4055     5.9113    9.3544
```

```
SERIAL NO.  VEHICLE DESCRIPTION                                                      PRINCIPAL  INTEREST    TOTAL  76-79 MAX

 1 11111656  OC STD/CARB            MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX    -0.3584   0.0       -0.3584    0.0
 2 21112656  OC STD/CARB            SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX    -0.3584   0.0       -0.3584    0.0
 3 34113656  OC STD/CARB            COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX    -0.3584   0.0       -0.3584    0.0
 4 44115656  OC STD/CARB            INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313   0.0       -2.0313    0.0
 5 44116656  OC STD/CARB            INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313   0.0       -2.0313    0.0
 6 54117656  OC STD/CARB             STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313   0.0       -2.0313    0.0
 7 64118656  OC STD/CARB             LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313   0.0       -2.0313    0.0
 8 11111655  OC STD/CARB    AI/EGR  MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     0.4102   0.0739     0.4841    1.3171
 9 21112655  OC STD/CARB    AI/EGR  SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     0.4102   0.0739     0.4841    1.3171
10 34113655  OC STD/CARB    AI/EGR  COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX     0.4102   0.0739     0.4841    1.3171
11 44115655  OC STD/CARB    AI/EGR  INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -1.2627   0.0739    -1.1888    1.3171
12 44116655  OC STD/CARB    AI/EGR  INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -1.2627   0.0739    -1.1888    1.3171
13 54117655  OC STD/CARB    AI/EGR   STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -1.2627   0.0739    -1.1888    1.3171
14 64118655  OC STD/CARB    AI/EGR   LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -1.2627   0.0739    -1.1888    1.3171
15 11111655  OC STD/CARB       EGR  MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX    -0.3584   0.0       -0.3584    0.0
16 21112655  OC STD/CARB       EGR  SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX    -0.3584   0.0       -0.3584    0.0
17 34113655  OC STD/CARB       EGR  COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX    -0.3584   0.0       -0.3584    0.0
18 44115655  OC STD/CARB       EGR  INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -1.9556   0.0073    -1.9483    0.1297
19 44116655  OC STD/CARB       EGR  INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -1.9556   0.0073    -1.9483    0.1297
20 54117655  OC STD/CARB       EGR   STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -1.9556   0.0073    -1.9483    0.1297
21 64118655  OC STD/CARB       EGR   LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -1.9556   0.0073    -1.9483    0.1297
22 11111469  OC STD/CARB            MINI I4  90-CID M/TR 2.0HC 23CO  NRNOX    -0.3584   0.0       -0.3584    0.0
23 21112469  OC STD/CARB            SUBC I4 153-CID M/TR 2.0HC 23CO  NRNOX    -0.3584   0.0       -0.3584    0.0
24 34113469  OC STD/CARB            COMP I6 250-CID A/TR 2.0HC 23CO  NRNOX    -0.3584   0.0       -0.3584    0.0
25 44115469  OC STD/CARB            INTA V8 290-CID A/TR 2.0HC 23CO  NRNOX    -2.0313   0.0       -2.0313    0.0
26 44116469  OC STD/CARB            INTB V8 350-CID A/TR 2.0HC 23CO  NRNOX    -2.0313   0.0       -2.0313    0.0
27 54117469  OC STD/CARB             STD V8 400-CID A/TR 2.0HC 23CO  NRNOX    -2.0313   0.0       -2.0313    0.0
28 64118469  OC STD/CARB             LUX V8 500-CID A/TR 2.0HC 23CO  NRNOX    -2.0313   0.0       -2.0313    0.0
29 11121346  OC VEN/CARB  AI/DEGR   MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     2.4024   0.2134     2.6159    3.5868
30 21122346  OC VEN/CARB  AI/DEGR   SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     2.4024   0.2134     2.6159    3.5868
31 34123346  OC VEN/CARB  AI/DEGR   COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX     2.4024   0.2134     2.6159    3.5868
32 44125346  OC VEN/CARB  AI/DEGR   INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     2.4024   0.2134     2.6159    3.5868
33 44126346  OC VEN/CARB  AI/DEGR   INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     2.2266   0.2017     2.4283    3.7942
34 54127346  OC VEN/CARB  AI/DEGR    STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX     2.2266   0.2017     2.4283    3.7942
35 64128346  OC VEN/CARB  AI/DEGR    LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX     2.2266   0.2017     2.4283    3.7942
36 11121346  OC VEN/CARB DEGR/HCAT  MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX    11.0204   0.7336    11.7540   17.2889
37 21122346  OC VEN/CARB DEGR/HCAT  SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX    11.0204   0.7336    11.7540   17.2889
38 34123346  OC VEN/CARB DEGR/HCAT  COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX    11.0204   0.7336    11.7540   17.2889
39 44125346  OC VEN/CARB DEGR/HCAT  INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX    11.0204   0.7336    11.7540   17.2889
40 44126346  OC VEN/CARB DEGR/HCAT  INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     4.5527   0.3206     4.8733    7.5536
41 54127346  OC VEN/CARB DEGR/HCAT   STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX     4.5527   0.3206     4.8733    7.5536

                                                                                                     INVESTMENT SUMMARY
                                                                                                     SCENARIO A/ED
 SERIAL NO.  VEHICLE DESCRIPTION                                                     PRINCIPAL  INTEREST     TOTAL  76-79 MAX

  42 64128346  OC VEN/CARB DEGR/HCAT   LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX          4.5527    0.3206     4.8733     7.5536
  43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX       11.7889    0.8075    12.5965    18.6061
  44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX       11.7889    0.8075    12.5965    18.6061
  45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX       11.7889    0.8075    12.5965    18.6061
  46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX       11.7889    0.8075    12.5965    18.6061
  47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX        5.3213    0.3945     5.7158     8.8707
  48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX        5.3213    0.3945     5.7158     8.8707
  49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX        5.3213    0.3945     5.7158     9.8707
  50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.       11.8928    0.8138    12.7066    18.7464
  51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.       11.8928    0.8138    12.7066    18.7464
  52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.       11.8928    0.8138    12.7066    18.7464
  53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.       11.7169    0.8020    12.5189    18.9538
  54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.        5.4251    0.4008     5.8259     9.0111
  55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO 2.        5.4251    0.4008     5.8259     9.0111
  56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.        5.4251    0.4008     5.8259     9.0111
 134 11141122  OC EFI/ECU   HNCCAT/O2 MINI I4  90-CID M/TR .4HC 3.4CO 1.0NOX         45.8657    2.6616    48.5273    52.6602
 135 21142122  OC EFI/ECU   HNCCAT/O2 SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NOX         45.8657    2.6616    48.5273    52.6602
 136 34143122  OC EFI/ECU   HNCCAT/O2 COMP I6 250-CID A/TR .4HC 3.4CO 1.0NOX         45.8657    2.6616    48.5273    52.6602
 137 44145122  OC EFI/ECU   HNCCAT/O2 INTA V8 290-CID A/TR .4HC 3.4CO 1.0NOX         45.8657    2.6616    48.5273    52.6602
 138 44146122  OC EFI/ECU   HNCCAT/O2 INTB V8 350-CID A/TR .4HC 3.4CO 1.0NOX         45.8657    2.6616    48.5273    52.6602
 139 54147122  OC EFI/ECU   HNCCAT/O2  STD V8 400-CID A/TR .4HC 3.4CO 1.0NOX         45.8657    2.6616    48.5273    52.6602
 140 64148122  OC EFI/ECU   HNCCAT/O2  LUX V8 500-CID A/TR .4HC 3.4CO 1.0NOX         45.8657    2.6616    48.5273    52.6602
 190 11631123 * D/DC    MFI            MINI I4  90-CID M/TR 0.4HC 3.4CO 2.0NOX        8.2710    0.8757     9.1467    26.5763
 191 21632123   D/DC    MFI            SUBC I4 165-CID M/TR 0.4HC 3.4CO 2.0NOX        8.2710    0.8757     9.1467    26.5763
 192 31633123   D/DC    MFI            COMP I6 250-CID M/TR 0.4HC 3.4CO 2.0NOX        8.2710    0.8757     9.1467    26.5763
 193 44635123   D/DC    MFI            INTA V8 250-CID A/TR 0.4HC 3.4CO 2.0NOX        8.2710    0.8757     9.1467    26.5763
 194 44636123   D/DC    MFI            INTB V8 250-CID A/TR 0.4HC 3.4CO 2.0NOX        8.2710    0.8757     9.1467    26.5763
 195 54637123   D/DC    MFI             STD V8 350-CID A/TR 0.4HC 3.4CO 2.0NOX        8.2710    0.8757     9.1467    26.5763
 196 64638123   D/DC    MFI             LUX V8 450-CID A/TR 0.4HC 3.4CO 2.0NOX        8.2710    0.8757     9.1467    26.5763


                                                                                                                INVESTMENT SUMMARY
                                                                                                                SCENARIO A/ED
```

```
SERIAL NO.  VEHICLE DESCRIPTION                                                      PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 1 11111656  OC STD/CARB                 MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX    -0.3584    0.0      -0.3584    0.0
 2 21112656  OC STD/CARB                 SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX    -0.3584    0.0      -0.3584    0.0
 3 34113656  OC STD/CARB                 COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX    -0.3584    0.0      -0.3584    0.0
 4 44115656  OC STD/CARB                 INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313    0.0      -2.0313    0.0
 5 44116656  OC STD/CARB                 INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313    0.0      -2.0313    0.0
 6 54117656  OC STD/CARB                  STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313    0.0      -2.0313    0.0
 7 64118656  OC STD/CARB                  LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313    0.0      -2.0313    0.0
 8 11111655  OC STD/CARB          AI/EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     0.5341    0.0827    0.6169    1.2997
 9 21112655  OC STD/CARB          AI/EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     0.5341    0.0827    0.6169    1.2997
10 34113655  OC STD/CARB          AI/EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX     0.5341    0.0827    0.6169    1.2997
11 44115655  OC STD/CARB          AI/EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -1.1387    0.0827   -1.0560    1.2997
12 44116655  OC STD/CARB          AI/EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -1.1387    0.0827   -1.0560    1.2997
13 54117655  OC STD/CARB          AI/EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -1.1387    0.0827   -1.0560    1.2997
14 64118655  OC STD/CARB          AI/EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -1.1387    0.0827   -1.0560    1.2997
15 11111655  OC STD/CARB             EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX    -0.3584    0.0      -0.3584    0.0
16 21112655  OC STD/CARB             EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX    -0.3584    0.0      -0.3584    0.0
17 34113655  OC STD/CARB             EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX    -0.3584    0.0      -0.3584    0.0
18 44115655  OC STD/CARB             EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -1.9434    0.0081   -1.9353    0.1280
19 44116655  OC STD/CARB             EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -1.9434    0.0081   -1.9353    0.1280
20 54117655  OC STD/CARB             EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -1.9434    0.0081   -1.9353    0.1280
21 64118655  OC STD/CARB             EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -1.9434    0.0081   -1.9353    0.1280
22 11111469  OC STD/CARB                 MINI I4  90-CID M/TR 2.0HC 23CO  NRNOX    -0.3584    0.0      -0.3584    0.0
23 21112469  OC STD/CARB                 SUBC I4 153-CID M/TR 2.0HC 23CO  NRNOX    -0.3584    0.0      -0.3584    0.0
24 34113469  OC STD/CARB                 COMP I6 250-CID A/TR 2.0HC 23CO  NRNOX    -0.3584    0.0      -0.3584    0.0
25 44115469  OC STD/CARB                 INTA V8 290-CID A/TR 2.0HC 23CO  NRNOX    -2.0313    0.0      -2.0313    0.0
26 44116469  OC STD/CARB                 INTB V8 350-CID A/TR 2.0HC 23CO  NRNOX    -2.0313    0.0      -2.0313    0.0
27 54117469  OC STD/CARB                  STD V8 400-CID A/TR 2.0HC 23CO  NRNOX    -2.0313    0.0      -2.0313    0.0
28 64118469  OC STD/CARB                  LUX V8 500-CID A/TR 2.0HC 23CO  NRNOX    -2.0313    0.0      -2.0313    0.0
29 11121346  OC VEN/CARB  AI/DEGR        MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     2.4705    0.2175    2.6880    3.4815
30 21122346  OC VEN/CARB  AI/DEGR        SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     2.4705    0.2175    2.6880    3.4815
31 34123346  OC VEN/CARB  AI/DEGR        COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX     2.4705    0.2175    2.6880    3.4815
32 44125346  OC VEN/CARB  AI/DEGR        INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     2.4705    0.2175    2.6880    3.4815
33 44126346  OC VEN/CARB  AI/DEGR        INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     2.3567    0.2108    2.5676    3.7845
34 54127346  OC VEN/CARB  AI/DEGR         STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX     2.3567    0.2108    2.5676    3.7845
35 64128346  OC VEN/CARB  AI/DEGR         LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX     2.3567    0.2108    2.5676    3.7845
36 11121346  OC VEN/CARB DEGR/HCAT       MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX    10.8171    0.7138   11.5309   17.4076
37 21122346  OC VEN/CARB DEGR/HCAT       SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX    10.8171    0.7138   11.5309   17.4076
38 34123346  OC VEN/CARB DEGR/HCAT       COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX    10.8171    0.7138   11.5309   17.4076
39 44125346  OC VEN/CARB DEGR/HCAT       INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX    10.8171    0.7138   11.5309   17.4076
40 44126346  OC VEN/CARB DEGR/HCAT       INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     4.5589    0.3209    4.8798    7.5614
41 54127346  OC VEN/CARB DEGR/HCAT        STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX     4.5589    0.3209    4.8798    7.5614

                                                                                                         INVESTMENT SUMMARY
                                                                                                         SCENARIO A/ED-2
 SERIAL NO.  VEHICLE DESCRIPTION                                                      PRINCIPAL  INTEREST      TOTAL 76-79 MAX

  42 64128346   OC VEN/CARB DEGR/HCAT    LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX          4.5589     0.3209     4.8798     7.5614
  43 11121234   OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX        11.7096     0.7965    12.5062    18.7073
  44 21122234   OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX        11.7096     0.7965    12.5062    18.7073
  45 34123234   OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX        11.7096     0.7965    12.5062    18.7073
  46 44125234   OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX        11.7096     0.7965    12.5062    18.7073
  47 44126234   OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX         5.4515     0.4037     5.8551     8.8611
  48 54127234   OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX         5.4515     0.4037     5.8551     8.8611
  49 64128234   OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX         5.4515     0.4037     5.8551     8.8611
  50 11121124   OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.       11.8360     0.8037    12.6397    18.8439
  51 21122124   OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.       11.8360     0.8037    12.6397    18.8439
  52 34123124   OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.       11.8360     0.8037    12.6397    18.8439
  53 44125124   OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.       11.7223     0.7970    12.5193    19.1469
  54 44126124   OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.        5.5778     0.4108     5.9887     8.9977
  55 54127124   OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO 2.        5.5778     0.4108     5.9887     8.9977
  56 64128124   OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.        5.5778     0.4108     5.9887     8.9977
 190 11631123 *  D/DC    MFI             MINI I4  90-CID M/TR 0.4HC 3.4CO 2.0NOX         8.7679     0.7839     9.5518    20.5909
 191 21632123    D/DC    MFI             SUBC I4 165-CID M/TR 0.4HC 3.4CO 2.0NOX         8.7679     0.7839     9.5518    20.5909
 192 31633123    D/DC    MFI             COMP I6 250-CID M/TR 0.4HC 3.4CO 2.0NOX         8.7679     0.7839     9.5518    20.5909
 193 44635123    D/DC    MFI             INTA V8 250-CID A/TR 0.4HC 3.4CO 2.0NOX         8.7679     0.7839     9.5518    20.5909
 194 44636123    D/DC    MFI             INTB V8 250-CID A/TR 0.4HC 3.4CO 2.0NOX         8.7679     0.7839     9.5518    20.5909
 195 54637123    D/DC    MFI              STD V8 350-CID A/TR 0.4HC 3.4CO 2.0NOX         8.7679     0.7839     9.5518    20.5909
 196 64638123    D/DC    MFI              LUX V8 450-CID A/TR 0.4HC 3.4CO 2.0NOX         8.7679     0.7839     9.5518    20.5909
```

INVESTMENT SUMMARY
SCENARIO A/ED-2

	SERIAL NO.	VEHICLE DESCRIPTION										PRINCIPAL	INTEREST	TOTAL	76-79 MAX
1	11111656	OC	STD/CARB		MINI	I4	90-CID	M/TR	3.4HC	39CO	4.0NOX	-0.5481	-0.0527	-0.6008	0.0
2	21112656	OC	STD/CARB		SUBC	I4	153-CID	M/TR	3.4HC	39CO	4.0NOX	-0.5481	-0.0527	-0.6008	0.0
3	34113656	OC	STD/CARB		COMP	I6	250-CID	A/TR	3.4HC	39CO	4.0NOX	-0.5481	-0.0577	-0.6058	0.0
4	44115656	OC	STD/CARB		INTA	V8	290-CID	A/TR	3.4HC	39CO	4.0NOX	-2.3383	-0.0962	-2.4345	0.0
5	44116656	OC	STD/CARB		INTB	V8	350-CID	A/TR	3.4HC	39CO	4.0NOX	-2.2210	-0.0527	-2.2737	0.0
6	54117656	OC	STD/CARB		STD	V8	400-CID	A/TR	3.4HC	39CO	4.0NOX	-2.7780	-0.0883	-2.8663	0.0
7	64118656	OC	STD/CARB		LUX	V8	500-CID	A/TR	3.4HC	39CO	4.0NOX	-2.2210	-0.0527	-2.2737	0.0
8	11111655	OC	STD/CARB	AI/EGR	MINI	I4	90-CID	M/TR	3.4HC	39CO	3.0NOX	7.2539	0.6465	7.9004	45.8103
9	21112655	OC	STD/CARB	AI/EGR	SUBC	I4	153-CID	M/TR	3.4HC	39CO	3.0NOX	7.2539	0.6465	7.9004	45.8103
10	34113655	OC	STD/CARB	AI/EGR	COMP	I6	250-CID	A/TR	3.4HC	39CO	3.0NOX	7.2539	0.6416	7.8955	45.8103
11	44115655	OC	STD/CARB	AI/EGR	INTA	V8	290-CID	A/TR	3.4HC	39CO	3.0NOX	5.4637	0.6031	6.0668	45.8103
12	44116655	OC	STD/CARB	AI/EGR	INTB	V8	350-CID	A/TR	3.4HC	39CO	3.0NOX	5.5810	0.6465	6.2276	45.8103
13	54117655	OC	STD/CARB	AI/EGR	STD	V8	400-CID	A/TR	3.4HC	39CO	3.0NOX	5.0240	0.6110	5.6350	45.8103
14	64118655	OC	STD/CARB	AI/EGR	LUX	V8	500-CID	A/TR	3.4HC	39CO	3.0NOX	5.5810	0.6465	6.2276	45.8103
15	11111655	OC	STD/CARB	EGR	MINI	I4	90-CID	M/TR	3.4HC	39CO	3.0NOX	6.2787	0.5683	6.8470	44.4535
16	21112655	OC	STD/CARB	EGR	SUBC	I4	153-CID	M/TR	3.4HC	39CO	3.0NOX	6.2787	0.5683	6.8470	44.4535
17	34113655	OC	STD/CARB	EGR	COMP	I6	250-CID	A/TR	3.4HC	39CO	3.0NOX	6.2787	0.5634	6.8420	44.4535
18	44115655	OC	STD/CARB	EGR	INTA	V8	290-CID	A/TR	3.4HC	39CO	3.0NOX	4.5845	0.5326	5.1171	44.5871
19	44116655	OC	STD/CARB	EGR	INTB	V8	350-CID	A/TR	3.4HC	39CO	3.0NOX	4.7018	0.5760	5.2778	44.5871
20	54117655	OC	STD/CARB	EGR	STD	V8	400-CID	A/TR	3.4HC	39CO	3.0NOX	4.1448	0.5405	4.6853	44.5871
21	64118655	OC	STD/CARB	EGR	LUX	V8	500-CID	A/TR	3.4HC	39CO	3.0NOX	4.7018	0.5760	5.2778	44.5871
22	11111469	OC	STD/CARB		MINI	I4	90-CID	M/TR	2.0HC	23CO	NRNOX	-0.5481	-0.0527	-0.6008	0.0
23	21112469	OC	STD/CARB		SUBC	I4	153-CID	M/TR	2.0HC	23CO	NRNOX	-0.5481	-0.0527	-0.6008	0.0
24	34113469	OC	STD/CARB		COMP	I6	250-CID	A/TR	2.0HC	23CO	NRNOX	-0.5481	-0.0577	-0.6058	0.0
25	44115469	OC	STD/CARB		INTA	V8	290-CID	A/TR	2.0HC	23CO	NRNOX	-2.3383	-0.0962	-2.4345	0.0
26	44116469	OC	STD/CARB		INTB	V8	350-CID	A/TR	2.0HC	23CO	NRNOX	-2.2210	-0.0527	-2.2737	0.0
27	54117469	OC	STD/CARB		STD	V8	400-CID	A/TR	2.0HC	23CO	NRNOX	-2.7780	-0.0883	-2.8663	0.0
28	64118469	OC	STD/CARB		LUX	V8	500-CID	A/TR	2.0HC	23CO	NRNOX	-2.2210	-0.0527	-2.2737	0.0
29	11121346	OC	VEN/CARB	AI/DEGR	MINI	I4	90-CID	M/TR	1.5HC	15CO	3.1NOX	2.7234	0.2316	2.9550	3.9976
30	21122346	OC	VEN/CARB	AI/DEGR	SUBC	I4	153-CID	M/TR	1.5HC	15CO	3.1NOX	2.7234	0.2316	2.9550	3.9976
31	34123346	OC	VEN/CARB	AI/DEGR	COMP	I6	250-CID	A/TR	1.5HC	15CO	3.1NOX	2.7234	0.2267	2.9501	3.9976
32	44125346	OC	VEN/CARB	AI/DEGR	INTA	V8	290-CID	A/TR	1.5HC	15CO	3.1NOX	2.6060	0.1882	2.7942	3.9976
33	44126346	OC	VEN/CARB	AI/DEGR	INTB	V8	350-CID	A/TR	1.5HC	15CO	3.1NOX	2.5537	0.2220	2.7757	4.1392
34	54127346	OC	VEN/CARB	AI/DEGR	STD	V8	400-CID	A/TR	1.5HC	15CO	3.1NOX	1.9966	0.1865	2.1831	4.1392
35	64128346	OC	VEN/CARB	AI/DEGR	LUX	V8	500-CID	A/TR	1.5HC	15CO	3.1NOX	2.5537	0.2220	2.7757	4.1392
36	11121346	OC	VEN/CARB	DEGR/HCAT	MINI	I4	90-CID	M/TR	1.5HC	15CO	3.1NOX	10.5455	0.6974	11.2428	16.9196
37	21122346	OC	VEN/CARB	DEGR/HCAT	SUBC	I4	153-CID	M/TR	1.5HC	15CO	3.1NOX	10.5455	0.6974	11.2428	16.9196
38	34123346	OC	VEN/CARB	DEGR/HCAT	COMP	I6	250-CID	A/TR	1.5HC	15CO	3.1NOX	10.5455	0.6924	11.2379	16.9196
39	44125346	OC	VEN/CARB	DEGR/HCAT	INTA	V8	290-CID	A/TR	1.5HC	15CO	3.1NOX	10.4281	0.6540	11.0821	16.9196
40	44126346	OC	VEN/CARB	DEGR/HCAT	INTB	V8	350-CID	A/TR	1.5HC	15CO	3.1NOX	4.9138	0.3652	5.2789	8.2610
41	54127346	OC	VEN/CARB	DEGR/HCAT	STD	V8	400-CID	A/TR	1.5HC	15CO	3.1NOX	4.3567	0.3296	4.6864	8.2610

INVESTMENT SUMMARY
SCENARIO A/ESC

```
  SERIAL NO.  VEHICLE DESCRIPTION                                                 PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 42 64128346  OC VEN/CARB DEGR/HCAT   LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX         4.9138     0.3652     5.2789     8.2610
 43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX     11.5207     0.7756    12.2963    18.2764
 44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX     11.5207     0.7756    12.2963    18.2764
 45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX     11.5207     0.7706    12.2913    18.2764
 46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX     11.4033     0.7322    12.1355    18.2764
 47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX      5.8890     0.4434     6.3324     9.6178
 48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX      5.3319     0.4078     5.7398     9.6178
 49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX      5.8890     0.4434     6.3324     9.6178
 50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.     11.6480     0.7787    12.4266    18.4310
 51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.     11.6480     0.7787    12.4266    18.4310
 52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.     11.6480     0.7737    12.4217    18.4310
 53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.     11.3609     0.7256    12.0865    18.5726
 54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.      6.0163     0.4465     6.4627     9.7724
 55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO 2.      5.4592     0.4109     5.8701     9.7724
 56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.      6.0163     0.4465     6.4627     9.7724
 85 11221346  OC/SC VVEN/CARB TR    MINI I4  90-CID M/TR .4HC 3.4CO .4NOX          33.8541     1.5320    35.3861    37.7855
 86 21222346  OC/SC VVEN/CARB TR    SUBC I4 153-CID M/TR .4HC 3.4CO .4NOX          11.0304     0.7140    11.7443    16.3116
 87 34223346  OC/SC VVEN/CARB TR    COMP I6 250-CID A/TR .4HC 3.4CO .4NOX          12.3797     0.8048    13.1846    16.5835
 88 44225346  OC/SC VVEN/CARB TR    INTA V8 290-CID A/TR .4HC 3.4CO .4NOX          15.8210     1.2268    17.0479    25.5143
 89 44226346  OC/SC VVEN/CARB TR    INTB V8 350-CID A/TR .4HC 3.4CO .4NOX          12.6852     1.0487    13.7339    24.2463
 90 54227346  OC/SC VVEN/CARB TR     STD V8 400-CID A/TR .4HC 3.4CO .4NOX          15.2403     1.2401    16.4804    26.8760
 91 64228346  OC/SC VVEN/CARB TR     LUX V8 500-CID A/TR .4HC 3.4CO .4NOX          15.3375     1.2587    16.5962    27.5909
134 11141122  OC EFI/ECU   HNCCAT/O2 MINI I4  90-CID M/TR .4HC 3.4CO 1.0NOX         2.1411     0.1971     2.3383     4.0194
135 21142122  OC EFI/ECU   HNCCAT/O2 SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NOX         2.1411     0.1971     2.3383     4.0194
136 34143122  OC EFI/ECU   HNCCAT/O2 COMP I6 250-CID A/TR .4HC 3.4CO 1.0NOX         2.1411     0.1922     2.3333     4.0194
137 44145122  OC EFI/ECU   HNCCAT/O2 INTA V8 290-CID A/TR .4HC 3.4CO 1.0NOX         2.0238     0.1537     2.1775     4.0194
138 44146122  OC EFI/ECU   HNCCAT/O2 INTB V8 350-CID A/TR .4HC 3.4CO 1.0NOX         2.1411     0.1971     2.3383     4.0194
139 54147122  OC EFI/ECU   HNCCAT/O2  STD V8 400-CID A/TR .4HC 3.4CO 1.0NOX         1.5841     0.1616     1.7457     4.0194
140 64148122  OC EFI/ECU   HNCCAT/O2  LUX V8 500-CID A/TR .4HC 3.4CO 1.0NOX         2.1411     0.1971     2.3383     4.0194
211 11231124  OC/SC   MFI/HCAT          MINI I4  90-CID M/TR .4HC 3.4CO 2.0NOX     47.1361     2.7958    49.9319    97.6195
212 21232124  OC/SC   MFI/HCAT          SUBC I4 153-CID M/TR .4HC 3.4CO 2.0NOX     17.4856     1.3568    18.8424    31.6921
213 34233124  OC/SC   MFI/HCAT          COMP I6 250-CID A/TR .4HC 3.4CO 2.0NOX     18.8350     1.4427    20.2777    31.9640
214 44235124  OC/SC   MFI/HCAT          INTA V8 290-CID A/TR .4HC 3.4CO 2.0NOX     20.7522     1.5775    22.3297    35.3249
215 44236124  OC/SC   MFI/HCAT          INTB V8 350-CID A/TR .4HC 3.4CO 2.0NOX     11.0368     1.0699    12.1067    23.0752
216 54237124  OC/SC   MFI/HCAT           STD V8 400-CID A/TR .4HC 3.4CO 2.0NOX     13.0349     1.2256    14.2606    25.7049
217 64238124  OC/SC   MFI/HCAT           LUX V8 500-CID A/TR .4HC 3.4CO 2.0NOX     13.6892     1.2798    14.9690    26.4198
```

```
SERIAL NO.  VEHICLE DESCRIPTION                                               PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 1 11111656  OC STD/CARB            MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX     -0.3584    0.0       -0.3584     0.0
 2 21112656  OC STD/CARB            SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX     -0.3584   -0.0010    -0.3595     0.0075
 3 34113656  OC STD/CARB            COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX     -1.8745   -0.0910    -1.9655     0.0
 4 44115656  OC STD/CARB            INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX     -3.4755   -0.0784    -3.5539     0.0
 5 44116656  OC STD/CARB            INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX     -2.0313    0.0       -2.0313     0.0
 6 54117656  OC STD/CARB             STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX     -3.1725   -0.0812    -3.2537     0.0
 7 64118656  OC STD/CARB             LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX     -2.0313    0.0       -2.0313     0.0
 8 11111655  OC STD/CARB     AI/EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX      0.6168    0.0782     0.6950     1.3568
 9 21112655  OC STD/CARB     AI/EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX      0.6166    0.0772     0.6939     1.3642
10 34113655  OC STD/CARB     AI/EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX     -0.8997   -0.0128    -0.9121     1.3569
11 44115655  OC STD/CARB     AI/EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX     -2.5003   -0.0002    -2.5005     1.3568
12 44116655  OC STD/CARB     AI/EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX     -1.0561    0.0782    -0.9779     1.3568
13 54117655  OC STD/CARB     AI/EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX     -2.1973   -0.0030    -2.2003     1.3568
14 64118655  OC STD/CARB     AI/EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX     -1.0561    0.0782    -0.9779     1.3568
15 11111655  OC STD/CARB        EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     -0.3584    0.0       -0.3584     0.0
16 21112655  OC STD/CARB        EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     -0.3584   -0.0010    -0.3595     0.0075
17 34113655  OC STD/CARB        EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX     -1.8745   -0.0910    -1.9655     0.0
18 44115655  OC STD/CARB        EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX     -3.3795   -0.0707    -3.4502     0.1336
19 44116655  OC STD/CARB        EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX     -1.9353    0.0077    -1.9276     0.1336
20 54117655  OC STD/CARB        EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX     -3.0765   -0.0735    -3.1500     0.1336
21 64118655  OC STD/CARB        EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX     -1.9353    0.0077    -1.9276     0.1336
22 11111469  OC STD/CARB            MINI I4  90-CID M/TR 2.0HC 23CO  NRNOX     -0.3584    0.0       -0.3584     0.0
23 21112469  OC STD/CARB            SUBC I4 153-CID M/TR 2.0HC 23CO  NRNOX     -0.3584   -0.0010    -0.3595     0.0075
24 34113469  OC STD/CARB            COMP I6 250-CID A/TR 2.0HC 23CO  NRNOX     -1.8745   -0.0910    -1.9655     0.0
25 44115469  OC STD/CARB            INTA V8 290-CID A/TR 2.0HC 23CO  NRNOX     -3.4755   -0.0784    -3.5539     0.0
26 44116469  OC STD/CARB            INTB V8 350-CID A/TR 2.0HC 23CO  NRNOX     -2.0313    0.0       -2.0313     0.0
27 54117469  OC STD/CARB             STD V8 400-CID A/TR 2.0HC 23CO  NRNOX     -3.1725   -0.0812    -3.2537     0.0
28 64118469  OC STD/CARB             LUX V8 500-CID A/TR 2.0HC 23CO  NRNOX     -2.0313    0.0       -2.0313     0.0
29 11121346  OC VEN/CARB  AI/DEGR   MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX      2.5395    0.2220     2.7616     3.8345
30 21122346  OC VEN/CARB  AI/DEGR   SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX      2.5395    0.2210     2.7605     3.8420
31 34123346  OC VEN/CARB  AI/DEGR   COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX      1.0235    0.1310     1.1545     3.8345
32 44125346  OC VEN/CARB  AI/DEGR   INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX      1.0953    0.1436     1.2389     3.8345
33 44126346  OC VEN/CARB  AI/DEGR   INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX      2.5035    0.2236     2.7271     4.1238
34 54127346  OC VEN/CARB  AI/DEGR    STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX      1.3623    0.1424     1.5047     4.1238
35 64128346  OC VEN/CARB  AI/DEGR    LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX      2.5035    0.2236     2.7271     4.1238
36 11121346  OC VEN/CARB DEGR/HCAT  MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     11.0617    0.7834    11.8451    17.6774
37 21122346  OC VEN/CARB DEGR/HCAT  SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     11.0617    0.7824    11.8441    17.6849
38 34123346  OC VEN/CARB DEGR/HCAT  COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX      9.5456    0.6924    10.2381    17.6774
39 44125346  OC VEN/CARB DEGR/HCAT  INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX      9.6175    0.7051    10.3225    17.6774
40 44126346  OC VEN/CARB DEGR/HCAT  INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX      4.9096    0.3735     5.2832     8.3219
41 54127346  OC VEN/CARB DEGR/HCAT   STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX      3.7684    0.2924     4.0608     8.3219
```

INVESTMENT SUMMARY
SCENARIO A/ESC-2

```
SERIAL NO.  VEHICLE DESCRIPTION                                              PRINCIPAL  INTEREST     TOTAL 76-79 MAX

42 64128346  OC VEN/CARB DEGR/HCAT    LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX     4.9096    0.3735    5.2832     8.3219
43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX   12.0369    0.8616   12.8986    19.0342
44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX   12.0369    0.8606   12.8975    19.0417
45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX   10.5209    0.7706   11.2915    19.0342
46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX   10.5927    0.7833   11.3759    19.0342
47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX    5.8849    0.4517    6.3366     9.6787
48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX    4.7436    0.3706    5.1142     9.6787
49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX    5.8849    0.4517    6.3366     9.6787
50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.   12.1642    0.8647   13.0289    19.1888
51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.   12.1642    0.8637   13.0279    19.1963
52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.   10.6481    0.7737   11.4218    19.1888
53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.   10.6839    0.7879   11.4719    19.4781
54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.    6.0121    0.4548    6.4670     9.8333
55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO 2.    4.8709    0.3736    5.2445     9.8333
56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.    6.0121    0.4548    6.4670     9.8333
85 11221346  OC/SC VVEN/CARB TR     MINI I4  90-CID M/TR .4HC 3.4CO .4NOX      28.4289    1.3807   29.8096    33.9367
86 21222346  OC/SC VVEN/CARB TR     SUBC I4 153-CID M/TR .4HC 3.4CO .4NOX       6.0001    0.5726    6.5727    12.8751
87 34223346  OC/SC VVEN/CARB TR     COMP I6 250-CID A/TR .4HC 3.4CO .4NOX       7.3456    0.6631    8.0087    13.1423
88 44225346  OC/SC VVEN/CARB TR     INTA V8 290-CID A/TR .4HC 3.4CO .4NOX      11.9480    1.0779   13.0259    19.9128
89 44226346  OC/SC VVEN/CARB TR     INTB V8 350-CID A/TR .4HC 3.4CO .4NOX       8.9510    0.9109    9.8619    18.7972
90 54227346  OC/SC VVEN/CARB TR      STD V8 400-CID A/TR .4HC 3.4CO .4NOX      11.5011    1.1012   12.6023    21.4023
91 64228346  OC/SC VVEN/CARB TR      LUX V8 500-CID A/TR .4HC 3.4CO .4NOX      11.6001    1.1202   12.7203    22.1295
```

INVESTMENT SUMMARY
SCENARIO A/ESC-2

```
SERIAL NO.  VEHICLE DESCRIPTION                                                                PRINCIPAL  INTEREST      TOTAL  76-79 MAX

 1 11111656  OC STD/CARB                 MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX    -0.3584     0.0       -0.3584     0.0
 2 21112656  OC STD/CARB                 SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX    -0.3584    -0.0242    -0.3826     0.0
 3 34113656  OC STD/CARB                 COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX   -11.6454    -0.6466   -12.2920     0.0
 4 44115656  OC STD/CARB                 INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313    -0.0236    -2.0549     0.0
 5 44116656  OC STD/CARB                 INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313     0.0       -2.0313     0.0
 6 54117656  OC STD/CARB                  STD V8 400-CID A/TR  .4HC 39CO 4.0NOX    -2.0313     0.0       -2.0313     0.0
 7 64118656  OC STD/CARB                  LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX    -2.0313     0.0       -2.0313     0.0
 8 11111655  OC STD/CARB          AI/EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     0.5367     0.0830     0.6197     1.3113
 9 21112655  OC STD/CARB          AI/EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     0.5367     0.0588     0.5955     1.3113
10 34113655  OC STD/CARB          AI/EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX   -10.7502    -0.5636   -11.3139     1.3113
11 44115655  OC STD/CARB          AI/EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -1.1362     0.0594    -1.0768     1.3113
12 44116655  OC STD/CARB          AI/EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -1.1362     0.0830    -1.0532     1.3113
13 54117655  OC STD/CARB          AI/EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -1.1362     0.0830    -1.0532     1.3113
14 64118655  OC STD/CARB          AI/EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -1.1362     0.0830    -1.0532     1.3113
15 11111655  OC STD/CARB             EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX    -0.3584     0.0       -0.3584     0.0
16 21112655  OC STD/CARB             EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX    -0.3584    -0.0242    -0.3826     0.0
17 34113655  OC STD/CARB             EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX   -11.6454    -0.6466   -12.2920     0.0
18 44115655  OC STD/CARB             EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -1.9432    -0.0155    -1.9586     0.1291
19 44116655  OC STD/CARB             EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -1.9432     0.0082    -1.9350     0.1291
20 54117655  OC STD/CARB             EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -1.9432     0.0082    -1.9350     0.1291
21 64118655  OC STD/CARB             EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -1.9432     0.0082    -1.9350     0.1291
22 11111469  OC STD/CARB                 MINI I4  90-CID M/TR 2.0HC 23CO  NRNOX    -0.3584     0.0       -0.3584     0.0
23 21112469  OC STD/CARB                 SUBC I4 153-CID M/TR 2.0HC 23CO  NRNOX    -0.3584    -0.0242    -0.3826     0.0
24 34113469  OC STD/CARB                 COMP I6 250-CID A/TR 2.0HC 23CO  NRNOX   -11.6454    -0.6466   -12.2920     0.0
25 44115469  OC STD/CARB                 INTA V8 290-CID A/TR 2.0HC 23CO  NRNOX    -2.0313    -0.0236    -2.0549     0.0
26 44116469  OC STD/CARB                 INTB V8 350-CID A/TR 2.0HC 23CO  NRNOX    -2.0313     0.0       -2.0313     0.0
27 54117469  OC STD/CARB                  STD V8 400-CID A/TR 2.0HC 23CO  NRNOX    -2.0313     0.0       -2.0313     0.0
28 64118469  OC STD/CARB                  LUX V8 500-CID A/TR 2.0HC 23CO  NRNOX    -2.0313     0.0       -2.0313     0.0
29 11121346  OC VEN/CARB  AI/DEGR    MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     2.5141     0.2272     2.7413     3.6055
30 21122346  OC VEN/CARB  AI/DEGR    SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     2.5141     0.2031     2.7172     3.6055
31 34123346  OC VEN/CARB  AI/DEGR    COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX    -8.7729    -0.4194    -9.1923     3.6055
32 44125346  OC VEN/CARB  AI/DEGR    INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     2.5141     0.2036     2.7177     3.6055
33 44126346  OC VEN/CARB  AI/DEGR    INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     2.3175     0.2233     2.5408     4.2396
34 54127346  OC VEN/CARB  AI/DEGR     STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX     2.3175     0.2233     2.5408     4.2396
35 64128346  OC VEN/CARB  AI/DEGR     LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX     2.3175     0.2233     2.5408     4.2396
36 11121346  OC VEN/CARB DEGR/HCAT   MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX    10.4860     0.6767    11.1627    17.0456
37 21122346  OC VEN/CARB DEGR/HCAT   SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX    10.4860     0.6525    11.1385    17.0456
38 34123346  OC VEN/CARB DEGR/HCAT   COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX    -0.8009     0.0300    -0.7709    17.0456
39 44125346  OC VEN/CARB DEGR/HCAT   INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX    10.4860     0.6530    11.1390    17.0456
40 44126346  OC VEN/CARB DEGR/HCAT   INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     4.4577     0.3250     4.7827     7.9134
41 54127346  OC VEN/CARB DEGR/HCAT    STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX     4.4577     0.3250     4.7827     7.9134
```

```
SERIAL NO.  VEHICLE DESCRIPTION                                                   PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 42 64128346  OC VEN/CARB DEGR/HCAT   LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX       4.4577    0.3250     4.7827     7.9134
 43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX    11.3811    0.7597    12.1408    18.3569
 44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX    11.3811    0.7355    12.1166    18.3569
 45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX     0.0942    0.1130     0.2072    18.3569
 46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX    11.3811    0.7360    12.1172    18.3569
 47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX     5.3528    0.4080     5.7608     9.2247
 48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX     5.3528    0.4080     5.7608     9.2247
 49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX     5.3528    0.4080     5.7608     9.2247
 50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.     11.5080    0.7669    12.2748    18.4949
 51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.     11.5080    0.7427    12.2507    18.4949
 52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.      0.2210    0.1202     0.3413    18.4949
 53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.     11.3113    0.7393    12.0506    19.1299
 54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V9 350-CID A/TR .4HC 3.4CO 2.      5.4797    0.4152     5.8948     9.3627
 55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO 2.      5.4797    0.4152     5.8948     9.3627
 56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.      5.4797    0.4152     5.8948     9.3627
134 11141122  OC EFI/ECU    HNCCAT/O2 MINI I4  90-CID M/TR .4HC 3.4CO 1.0NOX     52.0580    3.0227    55.0806    57.9195
135 21142122  OC EFI/ECU    HNCCAT/O2 SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NOX     52.0580    2.9985    55.0565    57.9195
136 34143122  OC EFI/ECU    HNCCAT/O2 COMP I6 250-CID A/TR .4HC 3.4CO 1.0NOX     40.7710    2.3760    43.1470    57.9195
137 44145122  OC EFI/ECU    HNCCAT/O2 INTA V8 290-CID A/TR .4HC 3.4CO 1.0NOX     52.0580    2.9990    55.0570    57.9195
138 44146122  OC EFI/ECU    HNCCAT/O2 INTB V9 350-CID A/TR .4HC 3.4CO 1.0NOX     52.0580    3.0227    55.0806    57.9195
139 54147122  OC EFI/ECU    HNCCAT/O2  STD V8 400-CID A/TR .4HC 3.4CO 1.0NOX     52.0580    3.0227    55.0806    57.9195
140 64148122  OC EFI/ECU    HNCCAT/O2  LUX V8 500-CID A/TR .4HC 3.4CO 1.0NOX     52.0580    3.0227    55.0806    57.9195
176 11321124  W  AV/CARB    IFC/HCAT MINI  1R 114-CID M/TR 0.4HC 3.4CO 2.0NOX  1060.8313   36.3226  1097.1543     0.0
177 21322124  W  AV/CARB    IFC/HCAT SUBC  2R 228-CID M/TR 0.4HC 3.4CO 2.0NOX   116.3116    3.8646   120.1761   137.5769
178 34323124  W  AV/CARB    IFC/HCAT COMP  2R 228-CID M/   0.4HC 3.4CO 2.0NOX   241.6012    9.0132   250.6144   330.4878
179 44325124  W  AV/CARB    IFC/HCAT INTA 2RH 273-CID A/TR 0.4HC 3.4CO 2.0NOX   317.4622   10.9161   328.3782   354.2903
180 44326124  W  AV/CARB    IFC/HCAT INTB 2RH 273-CID A/TR 0.4HC 3.4CO 2.0NOX   277.1609   10.3945   287.5552   303.8157
181 54327124  W  AV/CARB    IFC/HCAT  STD  4R 456-CID A/TR 0.4HC 3.4CO 2.0NOX    64.5913    2.0128    66.6041    77.2571
182 64328124  W  AV/CARB    IFC/HCAT  LUX  4R 456-CID A/TR 0.4HC 3.4CO 2.0NOX    64.5913    2.0128    66.6041    77.2571
```

INVESTMENT SUMMARY
SCENARIO A/EW

```
SERIAL NO.  VEHICLE DESCRIPTION                                                     PRINCIPAL  INTEREST      TOTAL 76-79 MAX

 1 11111656  OC STD/CARB             MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX     -2.5178   -0.2733   -2.7911    0.0
 2 21112656  OC STD/CARB             SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX     -2.8893   -0.3196   -3.2079    0.0
 3 34113656  OC STD/CARB             COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX    -14.1645   -0.8227  -14.9872    0.0
 4 44115656  OC STD/CARB             INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX     -8.9406   -0.5619   -9.5025    0.0
 5 44116656  OC STD/CARB             INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX     -5.6176   -0.3866   -6.0042    0.0
 6 54117656  OC STD/CARB              STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX     -6.8794   -0.4870   -7.3664    0.0
 7 64118656  OC STD/CARB              LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX     -7.0679   -0.5019   -7.5699    0.0
 8 11111655  OC STD/CARB      AI/EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     -0.7246   -0.1189   -0.8435    9.2153
 9 21112655  OC STD/CARB      AI/EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     -1.0961   -0.1642   -1.2603    9.2153
10 34113655  OC STD/CARB      AI/EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX    -12.3713   -0.5682  -13.0396    9.2153
11 44115655  OC STD/CARB      AI/EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX     -7.1474   -0.4075   -7.5549    9.2153
12 44116655  OC STD/CARB      AI/EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX     -3.8244   -0.2322   -4.0566    9.2153
13 54117655  OC STD/CARB      AI/EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX     -5.0862   -0.3326   -5.4188    9.2153
14 64118655  OC STD/CARB      AI/EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX     -5.2747   -0.3475   -5.6222    9.2153
15 11111655  OC STD/CARB         EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     -1.7917   -0.2075   -1.9992    7.7471
16 21112655  OC STD/CARB         EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     -2.1631   -0.2528   -2.4160    7.7471
17 34113655  OC STD/CARB         EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX    -13.4384   -0.7569  -14.1952    7.7471
18 44115655  OC STD/CARB         EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX     -8.1094   -0.4874   -8.5968    7.8916
19 44116655  OC STD/CARB         EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX     -4.7864   -0.3121   -5.0985    7.8916
20 54117655  OC STD/CARB         EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX     -6.0482   -0.4125   -6.4607    7.8916
21 64118655  OC STD/CARB         EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX     -6.2367   -0.4274   -6.6641    7.8916
22 11111469  OC STD/CARB             MINI I4  90-CID M/TR 2.0HC 23CO  NRNOX     -2.5178   -0.2733   -2.7911    0.0
23 21112469  OC STD/CARB             SUBC I4 153-CID M/TR 2.0HC 23CO  NRNOX     -2.8893   -0.3186   -3.2079    0.0
24 34113469  OC STD/CARB             COMP I6 250-CID A/TR 2.0HC 23CO  NRNOX    -14.1645   -0.8227  -14.9872    0.0
25 44115469  OC STD/CARB             INTA V8 290-CID A/TR 2.0HC 23CO  NRNOX     -8.9406   -0.5619   -9.5025    0.0
26 44116469  OC STD/CARB             INTB V8 350-CID A/TR 2.0HC 23CO  NRNOX     -5.6176   -0.3866   -6.0042    0.0
27 54117469  OC STD/CARB              STD V8 400-CID A/TR 2.0HC 23CO  NRNOX     -6.8794   -0.4870   -7.3664    0.0
28 64118469  OC STD/CARB              LUX V8 500-CID A/TR 2.0HC 23CO  NRNOX     -7.0679   -0.5019   -7.5699    0.0
29 11121346  OC VEN/CARB  AI/DEGR    MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX      2.2628    0.1938    2.4566    3.9483
30 21122346  OC VEN/CARB  AI/DEGR    SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX      1.8913    0.1485    2.0398    3.9483
31 34123346  OC VEN/CARB  AI/DEGR    COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX     -9.3839   -0.3555   -9.7394    3.9483
32 44125346  OC VEN/CARB  AI/DEGR    INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     -2.4871   -0.0948   -2.5819    3.9483
33 44126346  OC VEN/CARB  AI/DEGR    INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX      0.7891    0.0847    0.8738    4.4557
34 54127346  OC VEN/CARB  AI/DEGR     STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX     -0.4727   -0.0157   -0.4884    4.4557
35 64128346  OC VEN/CARB  AI/DEGR     LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX     -0.6612   -0.0306   -0.6918    4.4557
36 11121346  OC VEN/CARB DEGR/HCAT   MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     10.9132    0.7719   11.6850   18.3989
37 21122346  OC VEN/CARB DEGR/HCAT   SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     10.5417    0.7265   11.2682   18.3989
38 34123346  OC VEN/CARB DEGR/HCAT   COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX     -0.7335    0.2225   -0.5110   18.3989
39 44125346  OC VEN/CARB DEGR/HCAT   INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX      6.1633    0.4832    6.6465   18.3989
40 44126346  OC VEN/CARB DEGR/HCAT   INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX      3.1544    0.2363    3.3907    8.6247
41 54127346  OC VEN/CARB DEGR/HCAT    STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX      1.8927    0.1359    2.0285    8.6247

                                                                                                  INVESTMENT SUMMARY
                                                                                                  SCENARIO A/F1
 SERIAL NO.  VEHICLE DESCRIPTION                                                  PRINCIPAL  INTEREST     TOTAL  76-79 MAX

  42 64128346  OC VEN/CARB DEGR/HCAT   LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX        1.7041     0.1209     1.8251     8.6247
  43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX     11.9802     0.8605    12.8407    19.8671
  44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX     11.6088     0.8151    12.4239    19.8671
  45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX      0.3335     0.3111     0.6447    19.8671
  46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX      7.2303     0.5719     7.8022    19.8671
  47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX      4.2214     0.3249     4.5463    10.0929
  48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX      2.9597     0.2245     3.1842    10.0929
  49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX      2.7712     0.2096     2.9807    10.0929
  50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.     12.0453     0.8653    12.9105    19.8709
  51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.     11.6738     0.8199    12.4937    19.8709
  52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.      0.3986     0.3159     0.7145    19.8709
  53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.      7.2486     0.5808     7.8294    20.3783
  54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.      4.2865     0.3297     4.6161    10.0967
  55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V9 400-CID A/TR .4HC 3.4CO 2.      3.0247     0.2293     3.2540    10.0967
  56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.      2.8362     0.2143     3.0505    10.0967
 134 11141122  OC EFI/ECU   HNCCAT/O2 MINI I4  90-CID M/TR .4HC 3.4CO 1.0NOX       10.0958     1.0187    11.1145    27.8425
 135 21142122  OC EFI/ECU   HNCCAT/O2 SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NOX        9.7244     0.9733    10.6977    27.8425
 136 34143122  OC EFI/ECU   HNCCAT/O2 COMP I6 250-CID A/TR .4HC 3.4CO 1.0NOX       -1.5509     0.4693    -1.0815    27.8425
 137 44145122  OC EFI/ECU   HNCCAT/O2 INTA V8 290-CID A/TR .4HC 3.4CO 1.0NOX        5.3459     0.7301     6.0760    27.8425
 138 44146122  OC EFI/ECU   HNCCAT/O2 INTB V8 350-CID A/TR .4HC 3.4CO 1.0NOX        8.6689     0.9054     9.5742    27.8425
 139 54147122  OC EFI/ECU   HNCCAT/O2  STD V8 400-CID A/TR .4HC 3.4CO 1.0NOX        7.4071     0.8050     8.2121    27.8425
 140 64148122  OC EFI/ECU   HNCCAT/O2  LUX V8 500-CID A/TR .4HC 3.4CO 1.0NOX        7.2186     0.7900     8.0086    27.8425
 155 11231124  OC/SC/MFI EGR/HCAT          MINI I4  90-CID M/TR .4HC 3.4CO 1.0N    15.4249     1.2279    16.6527    41.9762
 156 21232124  OC/SC/MFI EGR/HCAT          SUBC I4 153-CID M/TR .4HC 3.4CO 1.0N    37.8689     2.0786    39.9475    66.2879
 157 34233124  OC/SC/MFI EGR/HCAT          COMP I6 250-CID A/TR .4HC 3.4CO 1.0N    27.0713     1.5968    28.6681    66.7953
 158 44235124  OC/SC/MFI EGR/HCAT          INTA V8 290-CID A/TR .4HC 3.4CO 1.0N    44.3131     2.2893    46.6024    78.2820
 159 44236124  OC/SC/MFI EGR/HCAT          INTB V8 350-CID A/TR .4HC 3.4CO 1.0N     5.3603     0.5359     5.8962    28.1125
 160 54227124  OC/SC/MFI EGR/HCAT           STD V8 400-CID A/TR .4HC 3.4CO 1.0N     4.0986     0.4355     4.5341    28.1125
 161 64238124  OC/SC/MFI EGR/HCAT           LUX V8 500-CID A/TR .4HC 3.4CO 1.0N     3.9100     0.4206     4.3306    28.1125
 197 11631123 * D/DC    MFI/ECU  MINI I4  90-CID M/TR 0.4HC 3.4CO 1.0NOX           10.8579     0.8945    11.7524    29.3671
 198 21632123   D/DC    MFI/ECU  SUBC I4 165-CID M/TR 0.4HC 3.4CO 1.0NOX           10.4864     0.8492    11.3356    29.3671
 199 31633123   D/DC    MFI/ECU  COMP I6 250-CID M/TR 0.4HC 3.4CO 1.0NOX           -0.7888     0.3452    -0.4437    29.3671
 200 44635123   D/DC    MFI/ECU  INTA V8 250-CID A/TR 0.4HC 3.4CO 1.0NOX            6.1080     0.6059     6.7139    29.3671
 201 44636123   D/DC    MFI/ECU  INTB V8 250-CID A/TR 0.4HC 3.4CO 1.0NOX            9.4309     0.7812    10.2121    29.3671
 202 54637123   D/DC    MFI/ECU   STD V8 350-CID A/TR 0.4HC 3.4CO 1.0NOX            8.1692     0.6808     8.8500    29.3671
 203 64638123   D/DC    MFI/ECU   LUX V8 450-CID A/TR 0.4HC 3.4CO 1.0NOX            7.9806     0.6659     8.6465    29.3671
 218 11121121  OC VEN/CARB AI/EFE/HNCAT MINI I4  90-CID M/TR .4HC 3.4CO 1.0NOX     18.0886     1.2797    19.3683    26.9175
 219 21122121  OC VEN/CARB AI/EFE/HNCAT SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NOX     18.0886     1.2797    19.3683    26.9175
 220 34123121  OC VEN/CARB AI/EFE/HNCAT COMP I6 250-CID A/TR .4HC 3.4CO 1.0NOX     11.3357     1.0096    12.3453    26.9175
 221 44125121  OC VEN/CARB AI/EFE/HNCAT INTA V8 290-CID A/TR .4HC 3.4CO 1.0NOX     18.0418     1.2839    19.3257    27.4249
 222 44126121  OC VEN/CARB AI/EFE/HNCAT INTB V8 350-CID A/TR .4HC 3.4CO 1.0NOX      8.8693     0.8225     9.6917    17.2901

                                                                                                        INVESTMENT SUMMARY
                                                                                                        SCENARIO A/F1
  SERIAL NO.  VEHICLE DESCRIPTION                                                        PRINCIPAL  INTEREST     TOTAL 76-79 MAX

223 54127121  OC VEN/CARB AI/EFE/HNCAT  STD V8 400-CID A/TR .4HC 3.4CO 1.0NOX    8.8693    0.8225    9.6917   17.2901
224 64128121  OC VEN/CARB AI/EFE/HNCAT  LUX V8 500-CID A/TR .4HC 3.4CO 1.0NOX    8.8693    0.8225    9.6917   17.2901
225 11221124  OC/SC VEN/CARB PEGR/TR    MINI I4  90-CID M/TR .4HC 3.4CO 1.0NO   13.4065    0.5692   13.9757   14.9103
226 21222124  OC/SC VEN/CARB PEGR/TR    SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NO   13.4065    0.5692   13.9757   14.9103
227 34223124  OC/SC VEN/CARB PEGR/TR    COMP I6 250-CID A/TR .4HC 3.4CO 1.0NO    6.6536    0.2991    6.9527   14.9103
228 44225124  OC/SC VEN/CARB PEGR/TR    INTA V8 290-CID A/TR .4HC 3.4CO 1.0NO   13.3597    0.5734   13.9331   15.4177
229 44226124  OC/SC VEN/CARB PEGR/TR    INTB V8 350-CID A/TR .4HC 3.4CO 1.0NO   13.3597    0.5734   13.9331   15.4177
230 54227124  OC/SC VEN/CARB PEGR/TR     STD V8 400-CID A/TR .4HC 3.4CO 1.0NO   13.3597    0.5734   13.9331   15.4177
231 64228124  OC/SC VEN/CARB PEGR/TR     LUX V8 500-CID A/TR .4HC 3.4CO 1.0NO   13.3597    0.5734   13.9331   15.4177
232 11321469  W  AV/CARB IFC/O2/HNGCAT  MINI 1R  114-CID M/TR .4HC 3.4CO 1.0N  305.4563   11.6107  317.0669  335.1021
233 21322469  W  AV/CARB IFC/O2/HNGCAT  SUBC 2R  228-CID M/TR .4HC 3.4CO 1.0N  726.5403   32.1445  758.6851  773.0291
234 31323469  W  AV/CARB IFC/O2/HNGCAT  COMP 2R  228-CID M/TR .4HC 3.4CO 1.0N  674.2681   29.7070  703.9751  718.6648
235 44325469  W  AV/CARB IFC/O2/HNGCAT  INTA 2RH 273-CID A/TR .4HC 3.4CO 1.0N  794.9124   32.3165  827.2288  850.6331
236 44326469  W  AV/CARB IFC/O2/HNGCAT  INTB 2RH 273-CID A/TR .4HC 3.4CO 1.0N  366.5442   13.5482  380.0923  397.3284
237 54327469  W  AV/CARB IFC/O2/HNGCAT   STD 4R  456-CID A/TR .4HC 3.4CO 1.0N  366.5442   13.5482  380.0923  397.3284
238 64328469  W  AV/CARB IFC/O2/HNGCAT   LUX 4R  456-CID A/TR .4HC 3.4CO 1.0N  366.5442   13.5482  380.0923  397.3284
```

INVESTMENT SUMMARY
SCENARIO A/F1

```
                                                                          PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 1 11111656  OC STD/CARB             MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX    -0.8657   -0.0393   -0.9050   -0.4087
 2 21112656  OC STD/CARB             SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX    -1.3090   -0.0843   -1.3933   -0.4087
 3 34113656  OC STD/CARB             COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX    -3.6438   -0.2240   -3.8678   -0.4087
 4 44115656  OC STD/CARB             INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX    -3.2873   -0.1764   -3.4637   -0.4087
 5 44116656  OC STD/CARB             INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX    -4.0865   -0.1689   -4.2554   -0.4087
 6 54117656  OC STD/CARB              STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX    -5.0690   -0.2159   -5.2849   -1.7185
 7 64118656  OC STD/CARB              LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX    -4.6028   -0.1468   -4.7495   -0.4087
 8 11111655  OC STD/CARB     AI/EGR  MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     0.1151    0.0413    0.1564    0.9673
 9 21112655  OC STD/CARB     AI/EGR  SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX    -0.3283   -0.0038   -0.3320    0.9673
10 34113655  OC STD/CARB     AI/EGR  COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX    -2.6630   -0.1435   -2.8065    0.9673
11 44115655  OC STD/CARB     AI/EGR  INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -2.3065   -0.0958   -2.4024    0.9673
12 44116655  OC STD/CARB     AI/EGR  INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -3.1057   -0.0884   -3.1941    0.9673
13 54117655  OC STD/CARB     AI/EGR   STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -4.0882   -0.1354   -4.2236   -0.3425
14 64118655  OC STD/CARB     AI/EGR   LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -3.6220   -0.0662   -3.6882    0.9673
15 11111655  OC STD/CARB        EGR  MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX    -0.6474   -0.0288   -0.6762   -0.1744
16 21112655  OC STD/CARB        EGR  SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX    -1.0908   -0.0739   -1.1646   -0.1744
17 34113655  OC STD/CARB        EGR  COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX    -3.4255   -0.2136   -3.6391   -0.1744
18 44115655  OC STD/CARB        EGR  INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -2.9940   -0.1590   -3.1530   -0.0620
19 44116655  OC STD/CARB        EGR  INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -3.7932   -0.1516   -3.9447   -0.0620
20 54117655  OC STD/CARB        EGR   STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -4.7757   -0.1985   -4.9742   -1.3718
21 64118655  OC STD/CARB        EGR   LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -4.3094   -0.1294   -4.4388   -0.0620
22 11111469  OC STD/CARB             MINI I4  90-CID M/TR 2.0HC 23CO   NRNOX    -0.8657   -0.0393   -0.9050   -0.4087
23 21112469  OC STD/CARB             SUBC I4 153-CID M/TR 2.0HC 23CO   NRNOX    -1.3090   -0.0843   -1.3933   -0.4087
24 34113469  OC STD/CARB             COMP I6 250-CID A/TR 2.0HC 23CO   NRNOX    -3.6438   -0.2240   -3.8678   -0.4087
25 44115469  OC STD/CARB             INTA V8 290-CID A/TR 2.0HC 23CO   NRNOX    -3.2873   -0.1764   -3.4637   -0.4087
26 44116469  OC STD/CARB             INTB V8 350-CID A/TR 2.0HC 23CO   NRNOX    -4.0865   -0.1689   -4.2554   -0.4087
27 54117469  OC STD/CARB              STD V8 400-CID A/TR 2.0HC 23CO   NRNOX    -5.0690   -0.2159   -5.2849   -1.7185
28 64118469  OC STD/CARB              LUX V8 500-CID A/TR 2.0HC 23CO   NRNOX    -4.6028   -0.1468   -4.7495   -0.4087
29 11121346  OC VEN/CARB  AI/DEGR    MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     2.0980    0.1809    2.2789    2.6723
30 21122346  OC VEN/CARB  AI/DEGR    SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     1.6546    0.1359    1.7905    2.6723
31 34123346  OC VEN/CARB  AI/DEGR    COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX    -0.6801   -0.0039   -0.6840    2.6723
32 44125346  OC VEN/CARB  AI/DEGR    INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     1.3492    0.0438    1.3930    2.6723
33 44126346  OC VEN/CARB  AI/DEGR    INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     0.5285    0.0593    0.5878    3.5363
34 54127346  OC VEN/CARB  AI/DEGR     STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX    -0.4541    0.0123   -0.4418    2.2265
35 64128346  OC VEN/CARB  AI/DEGR     LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX     0.0122    0.0814    0.0936    3.5363
36 11121346  OC VEN/CARB DEGR/HCAT   MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX    10.6009    0.7571   11.3581   15.8886
37 21122346  OC VEN/CARB DEGR/HCAT   SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX    10.1576    0.7121   10.8697   15.8886
38 34123346  OC VEN/CARB DEGR/HCAT   COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX     7.8228    0.5724    8.3952   15.8886
39 44125346  OC VEN/CARB DEGR/HCAT   INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     9.8521    0.6201   10.4722   15.8886
40 44126346  OC VEN/CARB DEGR/HCAT   INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     3.5405    0.2551    3.7955    8.7017
41 54127346  OC VEN/CARB DEGR/HCAT    STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX     2.5579    0.2081    2.7660    7.3919

                                                                                                   INVESTMENT SUMMARY
                                                                                                   SCENARIO A/I
```

```
SERIAL NO.  VEHICLE DESCRIPTION                                                      PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 42 64128346   OC VEN/CARB DEGR/HCAT   LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX          3.0242     0.2772      3.3014     8.7017
 43 11121234   OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX       11.3635     0.8272     12.1907    17.0302
 44 21122234   OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX       10.9201     0.7822     11.7023    17.0302
 45 34123234   OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX        8.5853     0.6425      9.2278    17.0302
 46 44125234   OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX       10.6146     0.6902     11.3048    17.0302
 47 44126234   OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX        4.3030     0.3252      4.6282     9.8433
 48 54127234   OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX        3.3204     0.2782      3.5986     8.5335
 49 64128234   OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX        3.7867     0.3473      4.1340     9.8433
 50 11121124   OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.       11.6526     0.8373     12.4899    17.7104
 51 21122124   OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.       11.2093     0.7923     12.0015    17.7104
 52 34123124   OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.        8.8745     0.6525      9.5270    17.7104
 53 44125124   OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.       10.8823     0.7082     11.5905    18.5743
 54 44126124   OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.        4.5921     0.3352      4.9274    10.5235
 55 54127124   OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO 2.        3.6096     0.2882      3.8978     9.2137
 56 64128124   OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.        4.0757     0.3574      4.4332    10.5235
 71 11121121   OC VEN/CARB AI/EFE/HNGCAT MINI I4 90 CID M/TR .4HC 3.4CO .4NOX        20.0169     1.5381     21.5550    34.1174
 72 21122121   OC VEN/CARB AI/EFE/HNGCAT SUBC I4 153CID M/TR .4HC 3.4CO .4NOX        20.0169     1.5381     21.5550    34.1174
 73 34123121   OC VEN/CARB AI/EFE/HNGCAT COMP I6 250CID A/TR .4HC 3.4CO .4NOX        20.0169     1.5381     21.5550    34.1174
 74 44125121   OC VEN/CARB AI/EFE/HNGCAT INTA V8 290CID A/TR .4HC 3.4CO .4NOX        19.9953     1.5461     21.5415    34.9814
 75 44126121   OC VEN/CARB AI/EFE/HNGCAT INTB V8 350CID A/TR .4HC 3.4CO .4NOX        17.8662     1.3893     19.2555    30.1906
 76 54127121   OC VEN/CARB AI/EFE/HNGCAT STD  V8 400CID A/TR .4HC 3.4CO .4NOX        17.8662     1.3893     19.2555    30.1906
 77 64128121   OC VEN/CARB AI/EFE/HNGCAT LUX  V8 500CID A/TR .4HC 3.4CO .4NOX        17.8662     1.3893     19.2555    30.1906
134 11141122   OC EFI/ECU   HNCCAT/O2 MINI I4  90-CID M/TR .4HC 3.4CO 1.0NOX          8.1384     0.7911      8.9294    20.7661
135 21142122   OC EFI/ECU   HNCCAT/O2 SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NOX          7.6950     0.7461      8.4411    20.7661
136 34143122   OC EFI/ECU   HNCCAT/O2 COMP I6 250-CID A/TR .4HC 3.4CO 1.0NOX          5.3603     0.6063      5.9666    20.7661
137 44145122   OC EFI/ECU   HNCCAT/O2 INTA V8 290-CID A/TR .4HC 3.4CO 1.0NOX          7.3896     0.6540      8.0435    20.7661
138 44146122   OC EFI/ECU   HNCCAT/O2 INTB V8 350-CID A/TR .4HC 3.4CO 1.0NOX          6.5904     0.6615      7.2518    20.7661
139 54147122   OC EFI/ECU   HNCCAT/O2  STD V8 400-CID A/TR .4HC 3.4CO 1.0NOX          5.6079     0.6145      6.2223    19.4563
140 64148122   OC EFI/ECU   HNCCAT/O2  LUX V8 500-CID A/TR .4HC 3.4CO 1.0NOX          6.0741     0.6836      6.7577    20.7661
141 11141121 OC EFI/ECU AI/PEGR/HNCCAT/O2 MINI I4 90 CID M/TR .4HC 3.4CO .4NO         9.3589     0.8780     10.2369    22.5879
142 21142121 OC EFI/ECU AI/PEGR/HNCCAT/O2 SUBC I4 153CID M/TR .4HC 3.4CO .4NO         8.9155     0.8329      9.7485    22.5879
143 34143121 OC EFI/ECU AI/PEGR/HNCCAT/O2 COMP I6 250CID A/TR .4HC 3.4CO .4NO         6.5808     0.6932      7.2740    22.5879
144 44145121 OC EFI/ECU AI/PEGR/HNCCAT/O2 INTA V8 290CID A/TR .4HC 3.4CO .4NO         8.6101     0.7409      9.3510    22.5879
145 44146121 OC EFI/ECU AI/PEGR/HNCCAT/O2 INTB V8 350CID A/TR .4HC 3.4CO .4NO         7.5712     0.7420      8.3132    22.1421
146 54147121 OC EFI/ECU AI/PEGR/HNCCAT/O2 STD  V8 400CID A/TR .4HC 3.4CO .4NO         6.5886     0.6950      7.2836    20.8322
147 64148121 OC EFI/ECU AI/PEGR/HNCCAT/O2 LUX  V8 500CID A/TR .4HC 3.4CO .4NO         7.0549     0.7641      7.8190    22.1421
```

```
SERIAL NO.  VEHICLE DESCRIPTION                                                      PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 1 11111656  OC STD/CARB             MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX    -0.8478   -0.0402   -0.8879    0.0
 2 21112656  OC STD/CARB             SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX    -1.2543   -0.0562   -1.3106    0.0
 3 34113656  OC STD/CARB             COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX    -5.2450   -0.3071   -5.5521    0.0
 4 44115656  OC STD/CARB             INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX    -3.5076   -0.2781   -3.7856    0.0
 5 44116656  OC STD/CARB             INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX    -3.9476   -0.1535   -4.1011    0.0
 6 54117656  OC STD/CARB              STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX    -5.0505   -0.2373   -5.2877    0.0
 7 64118656  OC STD/CARB              LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX    -4.5244   -0.1626   -4.6870    0.0
 8 11111655  OC STD/CARB      AI/EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     0.2389    0.0470    0.2859    1.5456
 9 21112655  OC STD/CARB      AI/EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX    -0.1677    0.0309   -0.1367    1.5456
10 34113655  OC STD/CARB      AI/EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX    -4.1584   -0.2199   -4.3783    1.5456
11 44115655  OC STD/CARB      AI/EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -2.4209   -0.1909   -2.6118    1.5456
12 44116655  OC STD/CARB      AI/EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -2.8609   -0.0663   -2.9272    1.5456
13 54117655  OC STD/CARB      AI/EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -3.9639   -0.1501   -4.1139    1.5456
14 64118655  OC STD/CARB      AI/EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -3.4378   -0.0754   -3.5132    1.5456
15 11111655  OC STD/CARB         EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX    -0.5570   -0.0273   -0.5843    0.3113
16 21112655  OC STD/CARB         EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX    -0.9635   -0.0434   -1.0069    0.3113
17 34113655  OC STD/CARB         EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX    -4.9542   -0.2942   -5.2485    0.3113
18 44115655  OC STD/CARB         EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX    -3.1384   -0.2579   -3.3963    0.4328
19 44116655  OC STD/CARB         EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -3.5784   -0.1333   -3.7118    0.4328
20 54117655  OC STD/CARB         EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX    -4.6814   -0.2171   -4.8984    0.4328
21 64118655  OC STD/CARB         EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -4.1553   -0.1424   -4.2977    0.4328
22 11111469  OC STD/CARB             MINI I4  90-CID M/TR 2.0HC 23CO   NRNOX    -0.8478   -0.0402   -0.8879    0.0
23 21112469  OC STD/CARB             SUBC I4 153-CID M/TR 2.0HC 23CO   NRNOX    -1.2543   -0.0562   -1.3106    0.0
24 34113469  OC STD/CARB             COMP I6 250-CID A/TR 2.0HC 23CO   NRNOX    -5.2450   -0.3071   -5.5521    0.0
25 44115469  OC STD/CARB             INTA V8 290-CID A/TR 2.0HC 23CO   NRNOX    -3.5076   -0.2781   -3.7856    0.0
26 44116469  OC STD/CARB             INTB V8 350-CID A/TR 2.0HC 23CO   NRNOX    -3.9476   -0.1535   -4.1011    0.0
27 54117469  OC STD/CARB              STD V8 400-CID A/TR 2.0HC 23CO   NRNOX    -5.0505   -0.2373   -5.2877    0.0
28 64118469  OC STD/CARB              LUX V8 500-CID A/TR 2.0HC 23CO   NRNOX    -4.5244   -0.1626   -4.6870    0.0
29 11121346  OC VEN/CARB  AI/DEGR    MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     1.8971    0.1750    2.0721    3.7478
30 21122346  OC VEN/CARB  AI/DEGR    SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     1.4906    0.1589    1.6495    3.7478
31 34123346  OC VEN/CARB  AI/DEGR    COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX    -2.5002   -0.0919   -2.5921    3.7478
32 44125346  OC VEN/CARB  AI/DEGR    INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     0.9101   -0.0629    0.8473    3.7478
33 44126346  OC VEN/CARB  AI/DEGR    INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     0.5470    0.0772    0.6242    4.1291
34 54127346  OC VEN/CARB  AI/DEGR     STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX    -0.5559   -0.0066   -0.5625    4.1291
35 64128346  OC VEN/CARB  AI/DEGR     LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX    -0.0299    0.0681    0.0382    4.1291
36 11121346  OC VEN/CARB DEGR/HCAT   MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX    10.0874    0.7571   10.8445   16.6007
37 21122346  OC VEN/CARB DEGR/HCAT   SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     9.6808    0.7411   10.4219   16.6007
38 34123346  OC VEN/CARB DEGR/HCAT   COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX     5.6901    0.4902    6.1804   16.6007
39 44125346  OC VEN/CARB DEGR/HCAT   INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     9.1004    0.5193    9.6197   16.6007
40 44126346  OC VEN/CARB DEGR/HCAT   INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX     3.2112    0.2523    3.4635    8.5767
41 54127346  OC VEN/CARB DEGR/HCAT    STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX     2.1083    0.1686    2.2769    8.5767

                                                                                                     INVESTMENT SUMMARY
                                                                                                     SCENARIO A/J
```

SERIAL NO.	VEHICLE DESCRIPTION	PRINCIPAL	INTEREST	TOTAL	76-79 MAX
42 64128346	OC VEN/CARB DEGR/HCAT LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX	2.6343	0.2433	2.8776	8.5767
43 11121234	OC VEN/CARB AI/DEGR/HCAT MINI I4 90-CID M/TR .9HC 9.0CO 2.0NOX	10.8833	0.8315	11.7147	17.8351
44 21122234	OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX	10.4767	0.8154	11.2921	17.8351
45 34123234	OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX	6.4860	0.5646	7.0506	17.8351
46 44125234	OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX	9.8963	0.5936	10.4899	17.8351
47 44126234	OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX	4.0071	0.3267	4.3337	9.8110
48 54127234	OC VEN/CARB AI/DEGR/HCAT STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX	2.9041	0.2429	3.1470	9.8110
49 64128234	OC VEN/CARB AI/DEGR/HCAT LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX	3.4302	0.3176	3.7478	9.8110
50 11121124	OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4 90-CID M/TR .4HC 3.4CO 2.	11.1826	0.8385	12.0212	18.3977
51 21122124	OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.	10.7761	0.8225	11.5986	18.3977
52 34123124	OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.	6.7853	0.5717	7.3570	18.3977
53 44125124	OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.	10.2725	0.6162	10.8886	18.7790
54 44126124	OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.	4.3064	0.3338	4.6402	10.3737
55 54127124	OC VEN/CARB AI/PEGR/HCAT/EFE STD V8 400-CID A/TR .4HC 3.4CO 2.	3.2035	0.2500	3.4535	10.3737
56 64129124	OC VEN/CARB AI/PEGR/HCAT/EFE LUX V8 500-CID A/TR .4HC 3.4CO 2.	3.7295	0.3247	4.0542	10.3737
71 11121121	OC VEN/CARB AI/EFE/HNGCAT MINI I4 90 CID M/TR .4HC 3.4CO .4NOX	22.6403	1.6312	24.2715	33.3871
72 21122121	OC VEN/CARB AI/EFE/HNGCAT SUBC I4 153CID M/TR .4HC 3.4CO .4NOX	22.6403	1.6312	24.2715	33.3871
73 34123121	OC VEN/CARB AI/EFE/HNGCAT COMP I6 250CID A/TR .4HC 3.4CO .4NOX	22.6403	1.6312	24.2715	33.3871
74 44125121	OC VEN/CARB AI/EFE/HNGCAT INTA V8 290CID A/TR .4HC 3.4CO .4NOX	22.7171	1.6467	24.3638	33.7684
75 44126121	OC VEN/CARB AI/EFE/HNGCAT INTB V8 350CID A/TR .4HC 3.4CO .4NOX	17.3729	1.4540	18.8269	29.5336
76 54127121	OC VEN/CARB AI/EFE/HNGCAT STD V8 400CID A/TR .4HC 3.4CO .4NOX	17.3729	1.4540	18.8269	29.5336
77 64129121	OC VEN/CARB AI/EFE/HNGCAT LUX V8 500CID A/TR .4HC 3.4CO .4NOX	17.3729	1.4540	18.8269	29.5336
134 11141122	OC EFI/ECU HNCCAT/O2 MINI I4 90-CID M/TR .4HC 3.4CO 1.0NOX	8.7913	0.9321	9.7234	24.9985
135 21142122	OC EFI/ECU HNCCAT/O2 SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NOX	8.3848	0.9160	9.3008	24.9985
136 34143122	OC EFI/ECU HNCCAT/O2 COMP I6 250-CID A/TR .4HC 3.4CO 1.0NOX	4.3941	0.6652	5.0593	24.9985
137 44145122	OC EFI/ECU HNCCAT/O2 INTA V8 290-CID A/TR .4HC 3.4CO 1.0NOX	7.8044	0.6942	8.4986	24.9985
138 44146122	OC EFI/ECU HNCCAT/O2 INTB V8 350-CID A/TR .4HC 3.4CO 1.0NOX	7.3644	0.8188	8.1832	24.9985
139 54147122	OC EFI/ECU HNCCAT/O2 STD V8 400-CID A/TR .4HC 3.4CO 1.0NOX	6.2615	0.7350	6.9965	24.9985
140 64148122	OC EFI/ECU HNCCAT/O2 LUX V8 500-CID A/TR .4HC 3.4CO 1.0NOX	6.7875	0.8097	7.5972	24.9985
141 11141121	OC EFI/ECU AI/PEGR/HNCCAT/O2 MINI I4 90 CID M/TR .4HC 3.4CO .4NO	9.9579	1.0222	10.9800	26.8829
142 21142121	OC EFI/ECU AI/PEGR/HNCCAT/O2 SUBC I4 153CID M/TR .4HC 3.4CO .4NO	9.5513	1.0061	10.5574	26.8829
143 34143121	OC EFI/ECU AI/PEGR/HNCCAT/O2 COMP I6 250CID A/TR .4HC 3.4CO .4NO	5.5606	0.7553	6.3159	26.8829
144 44145121	OC EFI/ECU AI/PEGR/HNCCAT/O2 INTA V8 290CID A/TR .4HC 3.4CO .4NO	8.9709	0.7843	9.7552	26.8829
145 44146121	OC EFI/ECU AI/PEGR/HNCCAT/O2 INTB V8 350CID A/TR .4HC 3.4CO .4NO	8.4510	0.9060	9.3570	26.5441
146 54147121	OC EFI/ECU AI/PEGR/HNCCAT/O2 STD V8 400CID A/TR .4HC 3.4CO .4NO	7.3481	0.8222	8.1703	26.5441
147 64148121	OC EFI/ECU AI/PEGR/HNCCAT/O2 LUX V8 500CID A/TR .4HC 3.4CO .4NO	7.8741	0.8969	8.7710	26.5441

INVESTMENT SUMMARY
SCENARIO A/J

```
SERIAL NO.  VEHICLE DESCRIPTION                                                      PRINCIPAL  INTEREST      TOTAL 76-79 MAX


 1 11111656  OC STD/CARB             MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX     75.9681    3.9038    79.8719    82.7803
 2 21112656  OC STD/CARB             SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX     28.6984    2.4890    31.1864    46.7613
 3 34113656  OC STD/CARB             COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX     34.1508    2.7592    36.9101    35.8324
 4 44115656  OC STD/CARB             INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX      9.0740    0.7891     9.8632    15.3274
 5 44116656  OC STD/CARB             INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX    -20.6527   -1.4590   -22.1117    0.0
 6 54117656  OC STD/CARB              STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX   -146.1001  -11.8544  -157.9545    -1.1670
 7 64118656  OC STD/CARB              LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX    -17.8728   -0.9632   -18.8360    0.0
 8 11111655  OC STD/CARB      AI/EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     77.1418    4.0138    81.1555    86.0300
 9 21112655  OC STD/CARB      AI/EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     29.8721    2.5979    32.4700    50.0110
10 34113655  OC STD/CARB      AI/EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX     35.3245    2.8692    38.1937    39.0822
11 44115655  OC STD/CARB      AI/EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX     10.2477    0.8990    11.1468    18.5772
12 44116655  OC STD/CARB      AI/EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -19.4790   -1.3491   -20.8281     3.2498
13 54117655  OC STD/CARB      AI/EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX   -144.9264  -11.7445  -156.6709     2.0828
14 64118655  OC STD/CARB      AI/EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -16.6991   -0.8533   -17.5524     3.2498
15 11111655  OC STD/CARB         EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     76.3427    3.9390    80.2817    84.7846
16 21112655  OC STD/CARB         EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     29.0730    2.5231    31.5961    48.7656
17 34113655  OC STD/CARB         EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX     34.5254    2.7944    37.3198    37.8367
18 44115655  OC STD/CARB         EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX      9.5273    0.8316    10.3589    17.4543
19 44116655  OC STD/CARB         EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -20.1994   -1.4165   -21.6159     2.1269
20 54117655  OC STD/CARB         EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX   -145.6468  -11.8120  -157.4588     0.9599
21 64118655  OC STD/CARB         EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -17.4196   -0.9207   -18.3403     2.1269
22 11111469  OC STD/CARB             MINI I4  90-CID M/TR 2.0HC 23CO  NRNOX     75.9681    3.9038    79.8719    82.7803
23 21112469  OC STD/CARB             SUBC I4 153-CID M/TR 2.0HC 23CO  NRNOX     28.6984    2.4890    31.1864    46.7613
24 34113469  OC STD/CARB             COMP I6 250-CID A/TR 2.0HC 23CO  NRNOX     34.1508    2.7592    36.9101    35.8324
25 44115469  OC STD/CARB             INTA V8 290-CID A/TR 2.0HC 23CO  NRNOX      9.0740    0.7891     9.8632    15.3274
26 44116469  OC STD/CARB             INTB V8 350-CID A/TR 2.0HC 23CO  NRNOX    -20.6527   -1.4590   -22.1117    0.0
27 54117469  OC STD/CARB              STD V8 400-CID A/TR 2.0HC 23CO  NRNOX   -146.1001  -11.8544  -157.9545    -1.1670
28 64118469  OC STD/CARB              LUX V8 500-CID A/TR 2.0HC 23CO  NRNOX    -17.8728   -0.9632   -18.8360    0.0
29 11121346  OC VEN/CARB  AI/DEGR    MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     78.6529    4.1184    82.7713    86.4329
30 21122346  OC VEN/CARB  AI/DEGR    SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     31.3832    2.7026    34.0857    50.4139
31 34123346  OC VEN/CARB  AI/DEGR    COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX     36.8356    2.9738    39.8095    39.4851
32 44125346  OC VEN/CARB  AI/DEGR    INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     13.4310    1.0037    14.4347    18.9801
33 44126346  OC VEN/CARB  AI/DEGR    INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX    -16.1704   -1.2358   -17.4063     4.0231
34 54127346  OC VEN/CARB  AI/DEGR     STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX   -141.6178  -11.6313  -153.2491     2.8561
35 64128346  OC VEN/CARB  AI/DEGR     LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX    -13.3906   -0.7400   -14.1306     4.0231
36 11121346  OC VEN/CARB DEGR/HCAT   MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     85.5474    4.5958    90.1432    97.1976
37 21122346  OC VEN/CARB DEGR/HCAT   SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     38.2777    3.1800    41.4576    61.1786
38 34123346  OC VEN/CARB DEGR/HCAT   COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX     43.7301    3.4512    47.1814    50.2497
39 44125346  OC VEN/CARB DEGR/HCAT   INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     20.3255    1.4811    21.8066    29.7447
40 44126346  OC VEN/CARB DEGR/HCAT   INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX    -13.4125   -1.0246   -14.4371     9.5561
41 54127346  OC VEN/CARB DEGR/HCAT    STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX   -138.8599  -11.4201  -150.2800     8.3891

                                                                                                      INVESTMENT SUMMARY
                                                                                                      SCENARIO A/JSV
```

```
SERIAL NO.  VEHICLE DESCRIPTION                                             PRINCIPAL  INTEREST      TOTAL 76-79 MAX

 42 64128346  OC VEN/CARB DEGR/HCAT    LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX    -10.6327   -0.5288   -11.1615    9.5561
 43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX    86.3465    4.6706    91.0171   98.4430
 44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX    39.0768    3.2547    42.3315   62.4240
 45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX    44.5292    3.5260    48.0552   51.4952
 46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX    21.1246    1.5559    22.6805   30.9901
 47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX   -12.6135   -0.9498   -13.5633   10.8016
 48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX  -138.0608  -11.3453  -149.4061    9.6346
 49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX    -9.8336   -0.4540   -10.2876   10.8016
 50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.    86.5856    4.6747    91.2603   98.9177
 51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.    39.3159    3.2589    42.5748   62.8987
 52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.    44.7683    3.5301    48.2985   51.9699
 53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.    21.4890    1.5686    23.0576   31.8353
 54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.   -12.3743   -0.9457   -13.3200   11.2763
 55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO 2. -137.8217  -11.3411  -149.1629   10.1093
 56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.    -9.5945   -0.4499   -10.0444   11.2763
 71 11121121  OC VEN/CARB AI/EFE/HNGCAT MINI I4 90 CID M/TR .4HC 3.4CO .4NOX     96.4955    5.3604   101.8559  112.0271
 72 21122121  OC VEN/CARB AI/EFE/HNGCAT SUBC I4 153CID M/TR .4HC 3.4CO .4NOX     48.8060    3.9221    52.7281   74.3976
 73 34123121  OC VEN/CARB AI/EFE/HNGCAT COMP I6 250CID A/TR .4HC 3.4CO .4NOX     55.1450    4.3449    59.4898   65.0792
 74 44125121  OC VEN/CARB AI/EFE/HNGCAT INTA V8 290CID A/TR .4HC 3.4CO .4NOX     32.0169    2.3438    34.3607   42.7829
 75 44126121  OC VEN/CARB AI/EFE/HNGCAT INTB V8 350CID A/TR .4HC 3.4CO .4NOX      4.6406    0.3965     5.0371   29.4879
 76 54127121  OC VEN/CARB AI/EFE/HNGCAT STD  V8 400CID A/TR .4HC 3.4CO .4NOX   -116.8798   -9.6692  -126.5489   28.3209
 77 64128121  OC VEN/CARB AI/EFE/HNGCAT LUX  V8 500CID A/TR .4HC 3.4CO .4NOX      7.8109    0.8853     8.6962   29.4879
134 11141122  OC EFI/ECU    HNCCAT/O2 MINI I4  90-CID M/TR .4HC 3.4CO 1.0NOX     85.6002    4.8622    90.4624  105.7056
135 21142122  OC EFI/ECU    HNCCAT/O2 SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NOX     38.3305    3.4463    41.7768   69.6866
136 34143122  OC EFI/ECU    HNCCAT/O2 COMP I6 250-CID A/TR .4HC 3.4CO 1.0NOX     43.7829    3.7176    47.5006   58.7577
137 44145122  OC EFI/ECU    HNCCAT/O2 INTA V8 290-CID A/TR .4HC 3.4CO 1.0NOX     20.3783    1.7475    22.1258   38.2527
138 44146122  OC EFI/ECU    HNCCAT/O2 INTB V8 350-CID A/TR .4HC 3.4CO 1.0NOX     -9.3484   -0.5006    -9.8491   22.9254
139 54147122  OC EFI/ECU    HNCCAT/O2  STD V8 400-CID A/TR .4HC 3.4CO 1.0NOX   -134.7958  -10.8961  -145.6919   21.7584
140 64148122  OC EFI/ECU    HNCCAT/O2  LUX V8 500-CID A/TR .4HC 3.4CO 1.0NOX     -6.5686   -0.0048    -6.5734   22.9254
141 11141121 OC EFI/ECU AI/PEGR/HNCCAT/O2 MINI I4 90 CID M/TR .4HC 3.4CO .4NO    86.7096    4.9498    91.6594  107.5130
142 21142121 OC EFI/ECU AI/PEGR/HNCCAT/O2 SUBC I4 153CID M/TR .4HC 3.4CO .4NO    39.4399    3.5339    42.9738   71.4940
143 34143121 OC EFI/ECU AI/PEGR/HNCCAT/O2 COMP I6 250CID A/TR .4HC 3.4CO .4NO    44.8924    3.8052    48.6975   60.5652
144 44145121 OC EFI/ECU AI/PEGR/HNCCAT/O2 INTA V8 290CID A/TR .4HC 3.4CO .4NO    21.4877    1.8350    23.3228   40.0602
145 44146121 OC EFI/ECU AI/PEGR/HNCCAT/O2 INTB V8 350CID A/TR .4HC 3.4CO .4NO    -8.1747   -0.3907    -8.5654   26.1751
146 54147121 OC EFI/ECU AI/PEGR/HNCCAT/O2 STD  V8 400CID A/TR .4HC 3.4CO .4NO  -133.6221  -10.7862  -144.4083   25.0081
147 64148121 OC EFI/ECU AI/PEGR/HNCCAT/O2 LUX  V8 500CID A/TR .4HC 3.4CO .4NO    -5.3949    0.1051    -5.2898   26.1751
```

INVESTMENT SUMMARY
SCENARIO A/JSV

```
SERIAL NO.  VEHICLE DESCRIPTION                                                     PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 1 11111656  OC STD/CARB                MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX     -0.6173   -0.0170   -0.6343    0.0
 2 21112656  OC STD/CARB                SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX     -0.6173   -0.0170   -0.6343    0.0
 3 34113656  OC STD/CARB                COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX     -2.2771   -0.0984   -2.3755    0.0
 4 44115656  OC STD/CARB                INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX     -2.7854   -0.0484   -2.8338    0.0
 5 44116656  OC STD/CARB                INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX     -2.6706   -0.0412   -2.7119    0.0
 6 54117656  OC STD/CARB                 STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX     -3.6744   -0.1247   -3.7991    0.0
 7 64118656  OC STD/CARB                 LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX     -3.0595   -0.0654   -3.1249    0.0
 8 11111655  OC STD/CARB        AI/EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX      0.4352    0.0632    0.4984    1.4932
 9 21112655  OC STD/CARB        AI/EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX      0.4352    0.0632    0.4984    1.4932
10 34113655  OC STD/CARB        AI/EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX     -1.2247   -0.0812   -1.2428    1.4932
11 44115655  OC STD/CARB        AI/EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX     -1.7330    0.0318   -1.7012    1.4932
12 44116655  OC STD/CARB        AI/EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX     -1.6182    0.0390   -1.5792    1.4932
13 54117655  OC STD/CARB        AI/EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX     -2.6220   -0.0444   -2.6664    1.4932
14 64118655  OC STD/CARB        AI/EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX     -2.0070    0.0148   -1.9922    1.4932
15 11111655  OC STD/CARB           EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     -0.4732   -0.0068   -0.4800    0.1520
16 21112655  OC STD/CARB           EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     -0.4732   -0.0068   -0.4800    0.1520
17 34113655  OC STD/CARB           EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX     -2.1330   -0.0882   -2.2212    0.1520
18 44115655  OC STD/CARB           EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX     -2.5519   -0.0313   -2.5833    0.2840
19 44116655  OC STD/CARB           EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX     -2.4371   -0.0242   -2.4613    0.2840
20 54117655  OC STD/CARB           EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX     -3.4409   -0.1076   -3.5485    0.2840
21 64118655  OC STD/CARB           EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX     -2.8260   -0.4830   -2.8743    0.2840
22 11111469  OC STD/CARB               MINI I4  90-CID M/TR 2.0HC 23CO  NRNOX     -0.6173   -0.0170   -0.6343    0.0
23 21112469  OC STD/CARB               SUBC I4 153-CID M/TR 2.0HC 23CO  NRNOX     -0.6173   -0.0170   -0.6343    0.0
24 34113469  OC STD/CARB               COMP I6 250-CID A/TR 2.0HC 23CO  NRNOX     -2.2771   -0.0984   -2.3755    0.0
25 44115469  OC STD/CARB               INTA V8 290-CID A/TR 2.0HC 23CO  NRNOX     -2.7854   -0.0484    2.8338    0.0
26 44116469  OC STD/CARB               INTB V8 350-CID A/TR 2.0HC 23CO  NRNOX     -2.6706   -0.0412   -2.7119    0.0
27 54117469  OC STD/CARB                STD V8 400-CID A/TR 2.0HC 23CO  NRNOX     -3.6744   -0.1247   -3.7991    0.0
28 64118469  OC STD/CARB                LUX V8 500-CID A/TR 2.0HC 23CO  NRNOX     -3.0595   -0.0654   -3.1249    0.0
29 11121346  OC VEN/CARB  AI/DEGR      MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX      1.8284    0.1411    1.9695    3.1051
30 21122346  OC VEN/CARB  AI/DEGR      SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX      1.8284    0.1411    1.9695    3.1051
31 34123346  OC VEN/CARB  AI/DEGR      COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX      0.1686    0.0597    0.2283    3.1051
32 44125346  OC VEN/CARB  AI/DEGR      INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX      1.3331    0.1097    1.4428    3.1051
33 44126346  OC VEN/CARB  AI/DEGR      INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX      1.8951    0.1766    2.0717    4.0022
34 54127346  OC VEN/CARB  AI/DEGR       STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX      0.8913    0.0932    0.9845    4.0022
35 64128346  OC VEN/CARB  AI/DEGR       LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX      1.5063    0.1525    1.6587    4.0022
36 11121346  OC VEN/CARB DEGR/HCAT     MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     11.6777    0.8719   12.5495   19.0595
37 21122346  OC VEN/CARB DEGR/HCAT     SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     11.6777    0.8719   12.5495   19.0595
38 34123346  OC VEN/CARB DEGR/HCAT     COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX     10.0178    0.7905   10.8083   19.0595
39 44125346  OC VEN/CARB DEGR/HCAT     INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     11.1823    0.8405   12.0228   19.0595
40 44126346  OC VEN/CARB DEGR/HCAT     INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX      3.7392    0.3437    4.0829    8.5665
41 54127346  OC VEN/CARB DEGR/HCAT      STD V8 400-CID A/TR 1.5HC 15CU 3.1NOX      2.7354    0.2602    2.9957    8.5665

                                                                                                       INVESTMENT SUMMARY
                                                                                                       SCENARIO A/K
```

```
SERIAL NO.  VEHICLE DESCRIPTION                                                     PRINCIPAL  INTEREST      TOTAL 76-79 MAX

 42 64128346  OC VEN/CARB DEGR/HCAT    LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX         3.3504    0.3195     3.6699    8.5665
 43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX      12.5860    0.9419    13.5280   20.4007
 44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX      12.5860    0.9419    13.5280   20.4007
 45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX      10.9262    0.8606    11.7867   20.4007
 46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX      12.0907    0.9106    13.0013   20.4007
 47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX       4.6476    0.4137     5.0613    9.9077
 48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX       3.6438    0.3303     3.9741    9.9077
 49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX       4.2587    0.3896     4.6483    9.9077
 50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.      12.6981    0.9485    13.6466   20.6462
 51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.      12.6981    0.9485    13.6466   20.6462
 52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.      11.0382    0.8672    11.9054   20.6462
 53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.      12.6499    0.9770    13.6269   21.5433
 54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.       4.7596    0.4203     5.1800   10.1532
 55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO 2.       3.7559    0.3369     4.0928   10.1532
 56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.       4.3708    0.3962     4.7669   10.1532
 71 11121121  OC VEN/CARB AI/EFE/HNGCAT MINI I4 90 CID M/TR .4HC 3.4CO .4NOX       26.1034    1.9907    28.0940   31.2006
 72 21122121  OC VEN/CARB AI/EFE/HNGCAT SUBC I4 153CID M/TR .4HC 3.4CO .4NOX       26.1034    1.9907    28.0940   31.2006
 73 34123121  OC VEN/CARB AI/EFE/HNGCAT COMP I6 250CID A/TR .4HC 3.4CO .4NOX       26.1034    1.9907    28.0940   31.2006
 74 44125121  OC VEN/CARB AI/EFE/HNGCAT INTA V8 290CID A/TR .4HC 3.4CO .4NOX       26.5506    2.0551    28.6010   32.0976
 75 44126121  OC VEN/CARB AI/EFE/HNGCAT INTB V8 350CID A/TR .4HC 3.4CO .4NOX       22.9370    1.7880    24.7251   27.5389
 76 54127121  OC VEN/CARB AI/EFE/HNGCAT STD  V8 400CID A/TR .4HC 3.4CO .4NOX       22.9370    1.7880    24.7251   27.5389
 77 64128121  OC VEN/CARB AI/EFE/HNGCAT LUX  V8 500CID A/TR .4HC 3.4CO .4NOX       22.9370    1.7880    24.7251   27.5389
134 11141122  OC EFI/ECU   HNCCAT/O2 MINI I4  90-CID M/TR .4HC 3.4CO 1.0NOX         7.3216    0.8116     8.1332   20.9094
135 21142122  OC EFI/ECU   HNCCAT/O2 SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NOX         7.3216    0.8116     8.1332   20.9094
136 34143122  OC EFI/ECU   HNCCAT/O2 COMP I6 250-CID A/TR .4HC 3.4CO 1.0NOX         5.6618    0.7302     6.3920   20.9094
137 44145122  OC EFI/ECU   HNCCAT/O2 INTA V8 290-CID A/TR .4HC 3.4CO 1.0NOX         6.8263    0.7802     7.6065   20.9094
138 44146122  OC EFI/ECU   HNCCAT/O2 INTB V8 350-CID A/TR .4HC 3.4CO 1.0NOX         6.9411    0.7874     7.7285   20.9094
139 54147122  OC EFI/ECU   HNCCAT/O2  STD V8 400-CID A/TR .4HC 3.4CO 1.0NOX         5.9373    0.7039     6.6413   20.9094
140 64148122  OC EFI/ECU   HNCCAT/O2  LUX V8 500-CID A/TR .4HC 3.4CO 1.0NOX         6.5522    0.7632     7.3155   20.9094
141 11141121 OC EFI/ECU AI/PEGR/HNCCAT/O2 MINI I4 90 CID M/TR .4HC 3.4CO .4NO        8.4133    0.8969     9.3102   22.5835
142 21142121 OC EFI/ECU AI/PEGR/HNCCAT/O2 SUBC I4 153CID M/TR .4HC 3.4CO .4NO        8.4133    0.8969     9.3102   22.5835
143 34143121 OC EFI/ECU AI/PEGR/HNCCAT/O2 COMP I6 250CID A/TR .4HC 3.4CO .4NO        6.7535    0.8155     7.5690   22.5835
144 44145121 OC EFI/ECU AI/PEGR/HNCCAT/O2 INTA V8 290CID A/TR .4HC 3.4CO .4NO        7.9180    0.8655     8.7835   22.5835
145 44146121 OC EFI/ECU AI/PEGR/HNCCAT/O2 INTB V8 350CID A/TR .4HC 3.4CO .4NO        7.9935    0.8676     8.8611   22.4025
146 54147121 OC EFI/ECU AI/PEGR/HNCCAT/O2 STD  V8 400CID A/TR .4HC 3.4CO .4NO        6.9898    0.7842     7.7739   22.4025
147 64148121 OC EFI/ECU AI/PEGR/HNCCAT/O2 LUX  V8 500CID A/TR .4HC 3.4CO .4NO        7.6047    0.8434     8.4481   22.4025
148 11131121  OC/MFI EGR/HNCCAT/ECU/O2     MINI I4   90CID M/TR .4HC 3.4CO .4N      37.0673    2.1252    39.1925   54.0628
149 21132121  OC/MFI EGR/HNCCAT/ECU/O2     SUBC I4  153CID M/TR .4HC 3.4CO .4N      19.9814    1.3392    21.3207   36.0195
150 34133121  OC/MFI EGR/HNCCAT/ECU/O2     COMP I6  250CID A/TR .4HC 3.4CO .4N      11.2424    1.1858    12.4282   36.7709
151 44135121  OC/MFI EGR/HNCCAT/ECU/O2     INTA  V8 290CID A/TR .4HC 3.4CO .4N      14.3254    1.4445    15.7699   39.7003
152 44136121  OC/MFI EGR/HNCCAT/ECU/O2     INTB  V8 350CID A/TR .4HC 3.4CO .4N      15.4781    1.4970    16.9751   40.8750
```

INVESTMENT SUMMARY
SCENARIO A/K

SERIAL NO.	VEHICLE DESCRIPTION		PRINCIPAL	INTEREST	TOTAL	76-79 MAX
153 54137121	OC/MFI EGR/HNCCAT/ECU/O2	STD V8 400CID A/TR .4HC 3.4CO .4N	33.6140	2.3121	35.9261	52.4847
154 64138121	OC/MFI EGR/HNCCAT/ECU/O2	LUX V8 500CID A/TR .4HC 3.4CO .4N	37.6236	2.4640	40.0877	56.1530

INVESTMENT SUMMARY
SCENARIO A/K

```
SERIAL NO.  VEHICLE DESCRIPTION                                                      PRINCIPAL  INTEREST     TOTAL 76-79 MAX

 1 11111656  OC STD/CARB             MINI I4  90-CID M/TR 3.4HC 39CO 4.0NOX     76.3511    3.9320    80.2831    82.9447
 2 21112656  OC STD/CARB             SUBC I4 153-CID M/TR 3.4HC 39CO 4.0NOX     29.1752    2.5261    31.7013    46.1942
 3 34113656  OC STD/CARB             COMP I6 250-CID A/TR 3.4HC 39CO 4.0NOX     34.8559    2.9139    37.7698    37.1248
 4 44115656  OC STD/CARB             INTA V8 290-CID A/TR 3.4HC 39CO 4.0NOX      9.9255    0.9083    10.8338    14.2919
 5 44116656  OC STD/CARB             INTB V8 350-CID A/TR 3.4HC 39CO 4.0NOX    -19.2125   -1.3069   -20.5194     0.0
 6 54117656  OC STD/CARB              STD V8 400-CID A/TR 3.4HC 39CO 4.0NOX   -142.9094  -11.5597  -154.4691    -1.1673
 7 64118656  OC STD/CARB              LUX V8 500-CID A/TR 3.4HC 39CO 4.0NOX    -16.1568   -0.8057   -16.9625     0.0
 8 11111655  OC STD/CARB       AI/EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     77.4571    4.0121    81.4692    84.4967
 9 21112655  OC STD/CARB       AI/EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     30.2812    2.6062    32.8874    47.7462
10 34113655  OC STD/CARB       AI/EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX     35.9619    2.9941    38.9559    38.6767
11 44115655  OC STD/CARB       AI/EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX     11.0315    0.9884    12.0199    15.8438
12 44116655  OC STD/CARB       AI/EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -18.1065   -1.2267   -19.3332     1.5520
13 54117655  OC STD/CARB       AI/EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX   -141.8033  -11.4796  -153.2829     0.3847
14 64118655  OC STD/CARB       AI/EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -15.0508   -0.7256   -15.7764     1.5520
15 11111655  OC STD/CARB          EGR MINI I4  90-CID M/TR 3.4HC 39CO 3.0NOX     76.5281    3.9396    80.4678    83.1345
16 21112655  OC STD/CARB          EGR SUBC I4 153-CID M/TR 3.4HC 39CO 3.0NOX     29.3522    2.5338    31.8860    46.3940
17 34113655  OC STD/CARB          EGR COMP I6 250-CID A/TR 3.4HC 39CO 3.0NOX     35.0329    2.9216    37.9545    37.3146
18 44115655  OC STD/CARB          EGR INTA V8 290-CID A/TR 3.4HC 39CO 3.0NOX     10.1940    0.9231    11.1171    14.6158
19 44116655  OC STD/CARB          EGR INTB V8 350-CID A/TR 3.4HC 39CO 3.0NOX    -18.9440   -1.2921   -20.2360     0.3239
20 54117655  OC STD/CARB          EGR  STD V8 400-CID A/TR 3.4HC 39CO 3.0NOX   -142.6409  -11.5449  -154.1857    -0.8434
21 64118655  OC STD/CARB          EGR  LUX V8 500-CID A/TR 3.4HC 39CO 3.0NOX    -15.8883   -0.7909   -16.6792     0.3239
22 11111469  OC STD/CARB             MINI I4  90-CID M/TR 2.0HC 23CO  NRNOX     76.3511    3.9320    80.2831    82.9447
23 21112469  OC STD/CARB             SUBC I4 153-CID M/TR 2.0HC 23CO  NRNOX     29.1752    2.5261    31.7013    46.1942
24 34113469  OC STD/CARB             COMP I6 250-CID A/TR 2.0HC 23CO  NRNOX     34.8559    2.9139    37.7698    37.1248
25 44115469  OC STD/CARB             INTA V8 290-CID A/TR 2.0HC 23CO  NRNOX      9.9255    0.9083    10.8338    14.2919
26 44116469  OC STD/CARB             INTB V8 350-CID A/TR 2.0HC 23CO  NRNOX    -19.2125   -1.3069   -20.5194     0.0
27 54117469  OC STD/CARB              STD V8 400-CID A/TR 2.0HC 23CO  NRNOX   -142.9094  -11.5597  -154.4691    -1.1673
28 64118469  OC STD/CARB              LUX V8 500-CID A/TR 2.0HC 23CO  NRNOX    -16.1568   -0.8057   -16.9625     0.0
29 11121346  OC VEN/CARB  AI/DEGR    MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     79.4031    4.1617    83.5647    87.2539
30 21122346  OC VEN/CARB  AI/DEGR    SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     32.2272    2.7558    34.9830    50.5034
31 34123346  OC VEN/CARB  AI/DEGR    COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX     37.9078    3.1437    41.0515    41.4339
32 44125346  OC VEN/CARB  AI/DEGR    INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     14.6496    1.1380    15.7876    18.6010
33 44126346  OC VEN/CARB  AI/DEGR    INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX    -14.8525   -1.1103   -15.9628     3.6969
34 54127346  OC VEN/CARB  AI/DEGR     STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX   -138.5494  -11.3632  -149.9125     2.5296
35 64128346  OC VEN/CARB  AI/DEGR     LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX    -11.7968   -0.6092   -12.4060     3.6969
36 11121346  OC VEN/CARB DEGR/HCAT   MINI I4  90-CID M/TR 1.5HC 15CO 3.1NOX     87.6014    4.7756    92.3770   100.7209
37 21122346  OC VEN/CARB DEGR/HCAT   SUBC I4 153-CID M/TR 1.5HC 15CO 3.1NOX     40.4255    3.3698    43.7953    63.9704
38 34123346  OC VEN/CARB DEGR/HCAT   COMP I6 250-CID A/TR 1.5HC 15CO 3.1NOX     46.1062    3.7576    49.8638    54.9009
39 44125346  OC VEN/CARB DEGR/HCAT   INTA V8 290-CID A/TR 1.5HC 15CO 3.1NOX     22.8480    1.7520    24.5999    32.0680
40 44126346  OC VEN/CARB DEGR/HCAT   INTB V8 350-CID A/TR 1.5HC 15CO 3.1NOX    -11.8620   -0.8572   -12.7192     9.7040
41 54127346  OC VEN/CARB DEGR/HCAT    STD V8 400-CID A/TR 1.5HC 15CO 3.1NOX   -135.5589  -11.1100  -146.6689     8.5367

                                                                                                    INVESTMENT SUMMARY
                                                                                                    SCENARIO A/KSV
```

```
SERIAL NO.  VEHICLE DESCRIPTION                                                  PRINCIPAL   INTEREST      TOTAL 76-79 MAX

 42 64128346  OC VEN/CARB DEGR/HCAT    LUX V8 500-CID A/TR 1.5HC 15CO 3.1NOX      -8.8063    -0.3560    -9.1624     9.7040
 43 11121234  OC VEN/CARB AI/DEGR/HCAT MINI I4  90-CID M/TR .9HC 9.0CO 2.0NOX    88.5304     4.8481    93.3784   102.0830
 44 21122234  OC VEN/CARB AI/DEGR/HCAT SUBC I4 9.03-CID M/TR .9HC 15CO 2.0NOX    41.3545     3.4422    44.7967    65.3325
 45 34123234  OC VEN/CARB AI/DEGR/HCAT COMP I6 250-CID A/TR .9HC 9.0CO 2.0NOX    47.0351     3.8301    50.8652    56.2630
 46 44125234  OC VEN/CARB AI/DEGR/HCAT INTA V8 290-CID A/TR .9HC 9.0CO 2.0NOX    23.7769     1.8244    25.6013    33.4301
 47 44126234  OC VEN/CARB AI/DEGR/HCAT INTB V8 350-CID A/TR .9HC 9.0CO 2.0NOX   -10.9330    -0.7848   -11.7178    11.0661
 48 54127234  OC VEN/CARB AI/DEGR/HCAT  STD V8 400-CID A/TR .9HC 9.0CO 2.0NOX -134.6299   -11.0376  -145.6675     9.8988
 49 64128234  OC VEN/CARB AI/DEGR/HCAT  LUX V8 500-CID A/TR .9HC 9.0CO 2.0NOX    -7.8774    -0.2836    -8.1609    11.0661
 50 11121124  OC VEN/CARB AI/PEGR/HCAT/EFE MINI I4  90-CID M/TR .4HC 3.4CO 2.    88.6179     4.8522    93.4701   102.3104
 51 21122124  OC VEN/CARB AI/PEGR/HCAT/EFE SUBC I4 153-CID M/TR .4HC 3.4CO 2.    41.4420     3.4463    44.8884    65.5600
 52 34123124  OC VEN/CARB AI/PEGR/HCAT/EFE COMP I6 250-CID A/TR .4HC 3.4CO 2.    47.1227     3.8342    50.9569    56.4905
 53 44125124  OC VEN/CARB AI/PEGR/HCAT/EFE INTA V8 290-CID A/TR .4HC 3.4CO 2.    23.5004     1.7954    25.2957    33.0452
 54 44126124  OC VEN/CARB AI/PEGR/HCAT/EFE INTB V8 350-CID A/TR .4HC 3.4CO 2.   -10.8455    -0.7806   -11.6261    11.2936
 55 54127124  OC VEN/CARB AI/PEGR/HCAT/EFE  STD V8 400-CID A/TR .4HC 3.4CO 2. -134.5424   -11.0334  -145.5758    10.1263
 56 64128124  OC VEN/CARB AI/PEGR/HCAT/EFE  LUX V8 500-CID A/TR .4HC 3.4CO 2.    -7.7898    -0.2794    -8.0692    11.2936
 71 11121121  OC VEN/CARB AI/EFE/HNGCAT MINI I4 90 CID M/TR .4HC 3.4CO .4NOX   100.6953     5.9863   106.6816   111.0806
 72 21122121  OC VEN/CARB AI/EFE/HNGCAT SUBC I4 153CID M/TR .4HC 3.4CO .4NOX    52.8597     4.5434    57.4032    73.2939
 73 34123121  OC VEN/CARB AI/EFE/HNGCAT COMP I6 250CID A/TR .4HC 3.4CO .4NOX    59.2001     4.9664    64.1665    63.9809
 74 44125121  OC VEN/CARB AI/EFE/HNGCAT INTA V8 290CID A/TR .4HC 3.4CO .4NOX    35.5778     2.9232    38.5009    40.6928
 75 44126121  OC VEN/CARB AI/EFE/HNGCAT INTB V8 350CID A/TR .4HC 3.4CO .4NOX    15.3949     1.2134    16.6082    35.6819
 76 54127121  OC VEN/CARB AI/EFE/HNGCAT STD  V8 400CID A/TR .4HC 3.4CO .4NOX  -106.2140    -8.8634  -115.0774    34.5146
 77 64128121  OC VEN/CARB AI/EFE/HNGCAT LUX  V8 500CID A/TR .4HC 3.4CO .4NOX    18.5662     1.7026    20.2687    35.6819
134 11141122  OC EFI/ECU   HNCCAT/O2 MINI I4  90-CID M/TR .4HC 3.4CO 1.0NOX     84.2995     4.7544    89.0539   102.9349
135 21142122  OC EFI/ECU   HNCCAT/O2 SUBC I4 153-CID M/TR .4HC 3.4CO 1.0NOX     37.1236     3.3485    40.4721    66.1844
136 34143122  OC EFI/ECU   HNCCAT/O2 COMP I6 250-CID A/TR .4HC 3.4CO 1.0NOX     42.8043     3.7364    46.5406    57.1149
137 44145122  OC EFI/ECU   HNCCAT/O2 INTA V8 290-CID A/TR .4HC 3.4CO 1.0NOX     19.5461     1.7307    21.2768    34.2820
138 44146122  OC EFI/ECU   HNCCAT/O2 INTB V8 350-CID A/TR .4HC 3.4CO 1.0NOX     -9.5919    -0.4844   -10.0764    19.9903
139 54147122  OC EFI/ECU   HNCCAT/O2  STD V8 400-CID A/TR .4HC 3.4CO 1.0NOX   -133.2888   -10.7373  -144.0261    18.8230
140 64148122  OC EFI/ECU   HNCCAT/O2  LUX V8 500-CID A/TR .4HC 3.4CO 1.0NOX     -6.5362     0.0167    -6.5195    19.9903
141 11141121 OC EFI/ECU AI/PEGR/HNCCAT/O2 MINI I4 90 CID M/TR .4HC 3.4CO .4NO    85.3872     4.8396    90.2268   104.6118
142 21142121 OC EFI/ECU AI/PEGR/HNCCAT/O2 SUBC I4 153CID M/TR .4HC 3.4CO .4NO    38.2113     3.4338    41.6451    67.8613
143 34143121 OC EFI/ECU AI/PEGR/HNCCAT/O2 COMP I6 250CID A/TR .4HC 3.4CO .4NO    43.8920     3.8216    47.7135    58.7918
144 44145121 OC EFI/ECU AI/PEGR/HNCCAT/O2 INTA V8 290CID A/TR .4HC 3.4CO .4NO    20.6338     1.8160    22.4497    35.9590
145 44146121 OC EFI/ECU AI/PEGR/HNCCAT/O2 INTB V8 350CID A/TR .4HC 3.4CO .4NO    -8.4859    -0.4043    -8.8902    21.5423
146 54147121 OC EFI/ECU AI/PEGR/HNCCAT/O2 STD  V8 400CID A/TR .4HC 3.4CO .4NO  -132.1928   -10.6571  -142.8399    20.3750
147 64148121 OC EFI/ECU AI/PEGR/HNCCAT/O2 LUX  V8 500CID A/TR .4HC 3.4CO .4NO    -5.4302     0.0969    -5.3334    21.5423
148 11131121  OC/MFI EGR/HNCCAT/ECU/O2     MINI I4    90CID M/TR .4HC 3.4CO .4N    96.5818     5.3417   101.9235   118.0616
149 21132121  OC/MFI EGR/HNCCAT/ECU/O2     SUBC I4   153CID M/TR .4HC 3.4CO .4N    41.1581     3.7082    44.8662    78.2925
150 34133121  OC/MFI EGR/HNCCAT/ECU/O2     COMP I6   250CID A/TR .4HC 3.4CO .4N    47.5188     4.1489    51.6678    70.1375
151 44135121  OC/MFI EGR/HNCCAT/ECU/O2     INTA  V8 290CID A/TR .4HC 3,4CO .4N    25.7880     2.3306    28.1186    49.4824
152 44136121  OC/MFI EGR/HNCCAT/ECU/O2     INTB  V8 350CID A/TR .4HC 3.4CO .4N    13.8592     0.5978    14.4570    47.3720

                                                                                                       INVESTMENT SUMMARY
                                                                                                       SCENARIO A/KSV
```

```
  SERIAL NO.  VEHICLE DESCRIPTION                                                      PRINCIPAL  INTEREST     TOTAL 76-79 MAX

153 54137121  OC/MFI EGR/HNCCAT/ECU/O2     STD  V8 400CID A/TR .4HC 3.4CO .4N  -88.2399   -7.2532  -95.4931   71.1484
154 64138121  OC/MFI EGR/HNCCAT/ECU/O2     LUX  V8 500CID A/TR .4HC 3.4CO .4N   30.6281    2.2417   32.8699   62.9448
```

```
INVESTMENT SUMMARY
SCENARIO A/KSV
```

TABLE M2

Summary of Investment Costs by Year for the Various Scenarios

```
             1970    1971    1972    1973    1974    1975    1976    1977    1978    1979    1980    1981    1982    1983    1984    1985

                                                             SCENARIO-ED

      IN'T      0       0       0       0  197576  131710  189484   14698   41488   37624   17724   58178   12994       0       0       0
      RV'Y      0       0       0       0  -10960   -9110  -12769   -2424   -7147   -2094  -14387   -2094  -10091   -2094       0       0
      NET       0       0       0       0  186616  122600  176715   12264   34341   35530    3337   56084    2903   -2094       0       0

                                                             SCENARIO ED-2

      IN'T      0       0       0       0  197576   58910  189484   48288   30988   17724   56924   21296   13413       0       0       0
      RV'Y      0       0       0       0  -10960   -9110  -12769   -2424   -7147   -2094  -14387   -2094  -10089   -2094       0       0
      NET       0       0       0       0  186616   49800  176715   45864   23841   15630   42537   19202    3324   -2094       0       0

                                                             SCENARIO FSC

      IN'T      0       0       0       0  197576   29110  312208   26688   77608   73394   73764   28711   43781    9117       0       0
      RV'Y      0       0       0       0  -10960   -9110  -12769  -10724   -7147   -4696  -12653   -2094   -8355   -4453       0       0
      NET       0       0       0       0  186616   20000  299439   15964   70461   68968   61111   26617   35426    4664       0       0

                                                             SCENARIO FSC-2

      IN'T      0       0       0       0  197576   29110  283088   47338  102688   84074   56124   22335   23975   10808       0       0
      RV'Y      0       0       0       0  -10960   -9110  -12769  -10724  -17449   -4696  -14387   -2094  -12678   -4453       0       0
      NET       0       0       0       0  186616   20000  270319   36614   85239   79378   41737   20241   11297    6355       0       0

                                                             SCENARIO FW

      IN'T      0       0       0       0  241905  249710  265014  122988   30988   65224   30824   36931   51681   30249       0       0
      RV'Y      0       0       0       0  -10960   -9110  -12769  -42724   -7147  -47194  -14387  -54010  -14708  -44685       0       0
      NET       0       0       0       0  230945  240600  252245   80264   23841   18030   16437  -17079   36973  -14436       0       0

                                                             SCENARIO FI

      IN'T      0       0       0       0  197576  108610  305584  292688  271838   40494   96594   45356   28237    5741       0       0
      RV'Y      0       0       0       0  -10960   -9110  -27220  -24834  -33172   -9887  -18602  -70097  -27596  -44685       0       0
      NET       0       0       0       0  186616   99500  278364  267854  238666   30607   77992  -24741     641  -38944       0       0

                                                             SCENARIO-I

      IN'T      0       0       0       0  282929  179578  369884  109422  148358   51394   68094   37594   28774   11708       0       0
      RV'Y      0       0       0       0  -10960  -17661  -32779  -28403  -18974  -26719  -27275   -2094  -10091   -4453       0       0
      NET       0       0       0       0  271869  161917  337105   81019  129384   24675   40819   35500   18683    7255       0       0
```

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
SCENARIO B																
IN'T	0	0	0	0	21034	1734	21034	1734	1900	0	0	0	0	0	0	0
RV'Y	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET	0	0	0	0	21034	1734	21034	1734	1900	0	0	0	0	0	0	0
SCENARIO B'J'																
IN'T	0	0	0	0	177458	82722	182772	7472	37054	52600	0	14622	29901	0	0	0
RV'Y	0	0	0	0	-8634	-8709	-14609	-11232	-10632	0	-6900	0	-4336	-2359	0	0
NET	0	0	0	0	168824	74013	168163	-3760	26422	52600	-6900	14622	25565	-2359	0	0
SCENARIO C																
IN'T	0	0	0	0	78882	15880	77818	17718	58518	11194	23324	39994	18772	12567	0	0
RV'Y	0	0	0	0	-9226	-9110	-11035	-2424	-4349	-2094	-12653	-2094	-8357	-2094	0	0
NET	0	0	0	0	69656	6770	66783	15294	54169	9100	10671	37900	10415	10473	0	0
SCENARIO C'J'																
IN'T	0	0	0	0	197576	97374	344788	22188	60618	53594	11194	20312	28959	0	0	0
RV'Y	0	0	0	0	-10960	-9110	-18669	-13326	-16385	-2094	-12653	-2094	-10089	-4453	0	0
NET	0	0	0	0	186616	88264	326119	8862	44233	51500	-1459	18218	18870	-4453	0	0
SCENARIO CSV																
IN'T	0	0	0	0	197576	106876	381652	201377	163075	94194	57990	41274	30994	11708	0	0
RV'Y	0	0	0	0	-10960	-9110	-23228	-23100	-33766	-7285	-34689	-2094	-10091	-4453	0	0
NET	0	0	0	0	186616	97766	358424	178277	129309	86909	23301	39180	20903	7255	0	0
SCENARIO-E																
IN'T	0	0	0	0	197576	108610	218784	23988	47688	18724	30824	21296	11391	5050	0	0
RV'Y	0	0	0	0	-10960	-9110	-12769	-2424	-7147	-2094	-14387	-2094	-10089	-2094	0	0
NET	0	0	0	0	186616	99500	206015	21564	40541	16630	16437	19202	1302	2956	0	0
SCENARIO E-2																
IN'T	0	0	0	0	197576	29110	205488	30188	30988	18724	93824	21296	11588	19448	0	0
RV'Y	0	0	0	0	-10960	-9110	-12769	-2424	-7147	-2094	-14387	-2094	-10089	-2094	0	0
NET	0	0	0	0	186616	20000	192719	27764	23841	16630	79437	19202	1499	17354	0	0

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
SCENARIO J																
IN'T	0	0	0	0	197576	106876	381652	201377	163075	94194	57990	41274	30994	11708	0	0
RV'Y	0	0	0	0	-10960	-9110	-23228	-23100	-33766	-7285	-34689	-2094	-10091	-4453	0	0
NET	0	0	0	0	186616	97766	358424	178277	129309	86909	23301	39180	20903	7255	0	0
SCENARIO JSV																
IN'T	0	0	0	0	229576	151110	340656	753756	468058	230994	548994	70064	75934	26986	0	0
RV'Y	0	0	0	0	-10960	-13310	-138124	-175951	-230758	-165918	-163271	-56603	-14711	-113082	0	0
NET	0	0	0	0	218616	137800	202532	577805	237300	65076	385723	13461	61223	-86096	0	0
SCENARIO K																
IN'T	0	0	0	0	197576	199226	181184	65918	260538	135990	67890	75983	34784	11708	0	0
RV'Y	0	0	0	0	-10960	-9110	-12769	-3018	-32942	-19773	-15371	-2804	-10253	-10737	0	0
NET	0	0	0	0	186616	190116	168415	62900	227596	116217	52519	73179	24531	971	0	0
SCENARIO KSV																
IN'T	0	0	0	0	229576	207526	192588	678022	571558	316394	550200	114800	68340	32884	0	0
RV'Y	0	0	0	0	-10960	-13310	-129586	-165037	-221936	-173525	-156776	-71983	-28374	-116821	0	0
NET	0	0	0	0	218616	194216	63002	512985	349622	142869	393424	42817	39966	-83937	0	0

APPENDIX N

Summary of Yearly Vehicle Operating Costs

(Compiled by Merrill L. Ebner and LeRoy H. Lindgren)

The procedures and program to estimate the cost of a particular scenario on the U.S. driving public are outlined in detail in Appendix G. In this appendix, selected output data from these analyses are presented. Since, as mentioned in Appendix G, all intermediate calculations were printed in the actual output report, a complete listing is too extensive to include here.

The final output reports list, on a yearly basis from 1970 to 1985, average cost per car, total costs for all vehicles-in-use, and incremental costs over Scenario A. Each report indicates the cost contribution for fuel, maintenance, and sticker price, and the total of these. All three of these reports (average, total, and incremental) are presented for Scenario A only. For all other scenarios, only the report for the incremental costs over Scenario A is presented. In these reports, numbers with no scale factor are in 1974 dollars; numbers with a scale factor of 1.00 D 08 are in hundred millions of 1974 dollars. The run date is the final time the program was run to generate the output report and is generally available long after the output report was initially available. Other abbreviations used in these output reports are defined in Table N1.

TABLE N1

Abbreviations Used in the Cost Summary Output Reports

Abbreviation		Meaning	
Scenario B'	=	B'J'	(Two-car strategy)
C'	=	C'J'	(Two-car strategy)
CS	=	CSV	(Small-car strategy)
ES	=	ESC	(Stratified charge)
ES-2	=	ESC-2	"
JS	=	JSV	(Small-car strategy)
KS	=	KSV	"
pv	=	present value in 1970 at a 4% discount rate	
investment	=	investment for new facilities from investment program (not used in this study)	

```
NAS SCNRO-A-120 FUDATA-CMLS10-059 AGFCTR-010810-060 SUMPGM-118              RUN DATE = 09/17/74


                                        AVERAGE COST SUMMARY REPORT

                  1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

AVG FUEL COST     443.   453.   467.   475.   467.   466.   454.   451.   456.   463.   462.   461.   461.   457.   455.   454.

AVG MAINT COST    22.6   25.5   27.4   28.2   28.1   28.6   28.4   28.9   29.6   30.4   30.4   30.5   30.6   30.4   30.2   30.2

AVG STKR PRICE  4443.2 4274.8 4281.6 4299.8 4277.7 4203.3 4150.8 4106.9 4048.9 4019.9 4007.0 4006.4 4008.7 4008.9 4011.6 4011.2

AVG INVESTMENT     0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0

TOT AVG COST    4909.1 4773.1 4775.6 4803.3 4772.8 4697.8 4632.8 4585.9 4534.7 4513.6 4498.9 4497.5 4500.3 4496.4 4496.4 4495.3

                                         TOTAL COST SUMMARY REPORT

                                         SCALE FACTOR=  1.000 08

                  1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

TOT FUEL COST   339.64 342.11 374.42 400.26 399.43 408.83 413.99 419.29 427.10 436.54 448.76 459.37 470.19 485.47 501.73 517.86
PV. FUEL COST   339.64 328.95 346.18 355.93 341.44 336.03 327.18 318.63 312.08 306.71 303.17 298.40 293.68 291.56 289.74 287.55

TOT MAINT COST   17.29  19.24  21.96  23.77  24.07  25.10  25.97  26.82  27.71  28.60  29.56  30.39  31.21  32.26  33.38  34.47
PV. MAINT COST   17.29  18.50  20.30  21.13  20.58  20.63  20.52  20.38  20.25  20.10  19.97  19.74  19.49  19.38  19.28  19.14

TOT STKR PRICE  370.52 438.20 466.74 490.30 433.85 441.22 450.94 461.82 471.17 484.24 499.63 516.98 535.45 554.23 574.06 594.01
PV. STKR PRICE  370.52 421.34 431.53 435.51 370.85 362.65 356.39 350.95 344.28 340.22 337.54 335.82 334.44 332.86 331.51 329.84

TOT INVESTMENT     0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0
PV. INVESTMENT     0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0

TOT  U.S. COST  727.45 799.55 863.13 914.33 857.35 875.15 890.90 907.93 925.98 949.39 977.961006.731036.851071.971109.171146.35
PV. U.S. COST   727.45 768.80 798.01 812.57 732.87 719.31 704.09 689.96 676.61 667.03 660.68 653.96 647.62 643.80 640.52 636.53

                                                                                                      COST SUMMARY
                                                                                                      NAS  SCENARIO-A
NAS SCNRO-A-120 FUDATA-LHL+10-357 AGFCTR-DV0410-060 SUMPGM-138               RUN DATE = 09/17/74

                                        INCREMENTAL COST SUMMARY REPORT

                                           SCALE FACTOR=  1.000 08

                  1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST     0.00   0.00   0.00  -0.00   0.00   0.00   0.00   0.00  -0.00   0.00   0.00  -0.00   0.00  -0.00   0.00  -0.00
PV. FUEL COST     0.00   0.00  -0.00  -0.00  -0.00   0.00   0.00  -0.00  -0.00   0.00  -0.00  -0.00   0.00   0.00   0.00   0.00

INC MAINT COST    0.00  -0.00   0.00   0.00   0.00  -0.00  -0.00  -0.00   0.00   0.00  -0.00  -0.00  -0.00   0.00  -0.00   0.00
PV. MAINT COST    0.00  -0.00   0.00   0.00  -0.00  -0.00   0.00  -0.00   0.00  -0.00  -0.00  -0.00   0.00  -0.00  -0.00   0.00

INC STKR PRICE   -0.00  -0.00   0.00   0.00  -0.00   0.00  -0.00   0.00  -0.00  -0.00   0.00   0.00  -0.00   0.00  -0.00   0.00
PV. STKR PRICE   -0.00   0.00  -0.00   0.00   0.00   0.00  -0.00  -0.00  -0.00   0.00  -0.00   0.00   0.00   0.00  -0.00  -0.00

INC INVESTMENT   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0
PV. INVESTMENT   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

INC U.S. COST     0.00  -0.00  -0.00   0.00  -0.00   0.00  -0.00   0.00  -0.00  -0.00  -0.00   0.00  -0.00  -0.00  -0.00  -0.00
PV. U.S. COST     0.00  -0.00  -0.00   0.00  -0.00   0.00   0.00  -0.00  -0.00   0.00  -0.00  -0.00  -0.00   0.00   0.00   0.00


                  TOTAL COST OF SCENARIO                          INCREMENTAL COST OF SCENARIO

                  TOT FUEL  COST        6845.00                   INC FUEL  COST          0.02
                  PV. FUEL  COST        5076.77                   PV. FUEL  COST          0.01

                  TOT MAINT COST         431.80                   INC MAINT COST         -0.00
                  PV. MAINT COST         316.67                   PV. MAINT COST         -0.01

                  TOT STKR PRICE        7783.05                   INC STKR PRICE          0.00
                  PV. STKR PRICE        5786.34                   PV. STKR PRICE          0.00

                  TOT INVESTMENT          0.0                     INC INVESTMENT          0.0
                  PV. INVESTMENT          0.0                     PV. INVESTMENT          0.0

                  TOT U.S.  COST       15059.85                   INC U.S.  COST         -0.01
                  PV. U.S.  COST       11179.77                   PV. U.S.  COST         -0.01


                                                                                          COST SUMMARY
                                                                                          NAS  SCENARIO-A
NAS SCNRO-8-120 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-138                RUN DATE = 01/21/75

                                      INCREMENTAL COST SUMMARY REPORT

                                         SCALE FACTOR=  1.000 08

                  1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST     0.00  -0.20   0.59   6.52  11.07  15.00  18.31  21.00  23.42  25.46  27.15  28.53  29.76  30.80  31.83  32.86

PV. FUEL COST     0.00  -0.19   0.54   5.80   9.46  12.33  14.47  15.96  17.11  17.89  18.34  18.53  18.59  18.50  18.38  18.25

INC MAINT COST    0.00   0.17   1.29   3.55   5.25   6.74   8.07   9.31  10.50  11.54  12.40  13.12  13.75  14.31  14.83  15.37

PV. MAINT COST    0.00   0.17   1.20   3.16   4.49   5.54   6.38   7.08   7.67   8.10   8.38   8.53   8.59   8.59   8.56   8.54

INC STKR PRICE   -0.00  -0.16   0.09   1.96   1.66   1.69   1.84   1.74   1.80   1.78   1.92   1.98   2.18   2.19   2.45   2.39

PV. STKR PRICE   -0.00  -0.14   0.08   1.74   1.43   1.39   1.45   1.32   1.31   1.25   1.29   1.29   1.37   1.31   1.41   1.32

INC INVESTMENT   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

PV. INVESTMENT   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

INC  U.S. COST    0.00  -0.18   1.96  12.04  17.99  23.43  28.21  32.06  35.72  38.77  41.46  43.64  45.69  47.29  49.11  50.61

PV. U.S. COST     0.00  -0.17   1.81  10.70  15.38  19.26  22.30  24.35  26.10  27.24  28.01  28.34  28.54  28.40  28.36  28.11


                  TOTAL COST OF SCENARIO                        INCREMENTAL COST OF SCENARIO

                  TOT FUEL  COST.       7147.09                 INC FUEL  COST        302.11
                  PV. FUEL  COST        5280.72                 PV. FUEL  COST        203.96

                  TOT MAINT COST         572.03                 INC MAINT COST        140.23
                  PV. MAINT COST         411.65                 PV. MAINT COST         94.97

                  TOT STKR PRICE        7808.55                 INC STKR PRICE         25.50
                  PV. STKR PRICE        5804.15                 PV. STKR PRICE         17.82

                  TOT INVESTMENT           0.0                  INC INVESTMENT          0.0
                  PV. INVESTMENT           0.0                  PV. INVESTMENT          0.0

                  TOT U.S.  COST       15527.67                 INC U.S.  COST        467.81
                  PV. U.S.  COST       11496.53                 PV. U.S.  COST        316.74

                                                                                               COST SUMMARY
                                                                                               NAS  SCENARIO-8
NAS SCNRO-8'J-131 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-130                RUN DATE = 01/22/75

                                                 INCREMENTAL COST SUMMARY REPORT

                                                     SCALE FACTOR=  1.00D 09

                   1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST     -0.02  -0.33   0.33   6.17   9.36   8.91   9.10  12.29  16.33  19.71  22.35  24.31  26.02  27.48  28.87  30.27
PV. FUEL COST     -0.02  -0.32   0.29   5.49   8.00   7.32   7.20   9.33  11.93  13.84  15.09  15.79  16.26  16.51  16.67  16.81

INC MAINT COST     0.00   0.16   1.27   3.52   4.93   5.32   5.85   6.95   8.08   9.04   9.77  10.36  10.93  11.48  12.00  12.53
PV. MAINT COST     0.00   0.16   1.18   3.13   4.21   4.38   4.62   5.28   5.90   6.34   6.60   6.73   6.83   6.89   6.93   6.96

INC STKR PRICE    -0.12  -0.87  -0.80   1.32   2.70  12.20  10.60   8.38  12.27  12.78  13.47  13.75  14.59  15.00  15.52  16.63
PV. STKR PRICE    -0.12  -0.83  -0.74   1.17   2.32  10.03   8.37   6.36   8.97   8.98   9.09   8.93   9.12   9.01   8.96   9.23

INC INVESTMENT    -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0
PV. INVESTMENT    -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

INC  U.S. COST    -0.14  -1.03   0.79  11.01  17.00  26.43  25.55  27.61  36.69  41.52  45.58  48.43  51.54  53.95  56.39  59.42
PV. U.S. COST     -0.14  -1.00   0.73   9.79  14.53  21.73  20.19  20.98  26.81  29.17  30.79  31.46  32.19  32.40  32.57  33.00


                      TOTAL COST OF SCENARIO                           INCREMENTAL COST OF SCENARIO

                      TOT FUEL  COST        7086.13                    INC FUEL  COST        241.15
                      PV. FUEL  COST        5236.97                    PV. FUEL  COST        160.21

                      TOT MAINT COST         544.00                    INC MAINT COST        112.20
                      PV. MAINT COST         392.93                    PV. MAINT COST         76.15

                      TOT STKR PRICE        7930.47                    INC STKR PRICE        147.43
                      PV. STKR PRICE        5885.19                    PV. STKR PRICE         98.86

                      TOT INVESTMENT           0.0                     INC INVESTMENT          0.0
                      PV. INVESTMENT           0.0                     PV. INVESTMENT          0.0

                      TOT U.S.  COST       15560.61                    INC U.S.  COST        500.74
                      PV. U.S.  COST       11514.99                    PV. U.S.  COST        335.20


                                                                                                   COST SUMMARY
                                                                                                   NAS  SCENARIO-8'
NAS SCNRO-C-121 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-138                RUN DATE = 09/17/74

                                                   INCREMENTAL COST SUMMARY REPORT

                                                      SCALE FACTOR=  1.00D 08

                       1970    1971    1972    1973    1974    1975    1976    1977    1978    1979    1980    1981    1982    1983    1984    1985

INC FUEL COST          0.00   -0.20    0.59    6.52    9.89    9.49    8.95    8.31    7.89    7.50    7.03    6.40    5.86    5.39    5.11    4.99
PV. FUEL COST          0.00   -0.19    0.54    5.80    8.45    7.80    7.07    6.32    5.77    5.27    4.75    4.16    3.66    3.24    2.95    2.77

INC MAINT COST         0.00    0.17    1.29    3.55    4.97    5.37    5.73    6.13    6.58    6.95    7.16    7.27    7.37    7.48    7.62    7.83
PV. MAINT COST         0.00    0.17    1.29    3.16    4.25    4.41    4.53    4.66    4.81    4.87    4.84    4.72    4.61    4.49    4.40    4.35

INC STKR PRICE        -0.00   -0.16    0.09    1.96    4.01   12.90   13.35   13.39   13.80   14.08   14.67   14.99   15.63   16.06   16.84   17.30
PV. STKR PRICE        -0.00   -0.14    0.09    1.74    3.44   10.60   10.55   10.17   10.09    9.90    9.90    9.74    9.77    9.64    9.72    9.60

INC INVESTMENT        -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0
PV. INVESTMENT        -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0

INC  U.S. COST         0.00   -0.18    1.96   12.04   18.87   27.75   28.03   27.84   28.27   28.52   28.85   28.67   28.86   28.92   29.57   30.10
PV. U.S. COST          0.00   -0.17    1.81   10.79   16.13   22.81   22.15   21.15   20.66   20.04   19.49   18.62   18.03   17.37   17.08   16.72


               TOTAL COST OF SCENARIO                             INCREMENTAL COST OF SCENARIO

               TOT FUEL  COST         6938.70                     INC FUEL  COST           93.72
               PV. FUEL  COST         5145.10                     PV. FUEL  COST           68.34

               TOT MAINT COST          517.28                     INC MAINT COST           85.48
               PV. MAINT COST          376.14                     PV. MAINT COST           59.46

               TOT STKR PRICE         7951.96                     INC STKR PRICE          168.91
               PV. STKR PRICE         5901.13                     PV. STKR PRICE          114.79

               TOT INVESTMENT            0.0                      INC [illegible]
               PV. INVESTMENT            0.0                      [illegible]

               TOT U.S.  COST        15407.[illegible]                        U.S   COST              [illegible]48.
               PV. U.S.  COST        114[illegible]2.                      PV. U.S.                  [illegible]42.
```

```
NAS SCNRO-C'J-136 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-138              RUN DATE = 09/17/74


                                            INCREMENTAL COST SUMMARY REPORT

                                               SCALE FACTOR=  1.000 08

                    1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST      -0.02  -0.33   0.33   6.17   9.36   9.91   8.45   9.92  10.56  11.79  12.54  12.84  13.00  13.02  13.17  13.48
PV. FUEL COST      -0.02  -0.32   0.29   5.49   8.00   7.32   6.68   6.78   7.71   8.28   8.47   8.34   8.12   7.83   7.61   7.49

INC MAINT COST      0.00   0.16   1.27   3.52   4.93   5.32   5.67   6.08   6.59   7.00   7.24   7.37   7.49   7.62   7.77   7.99
PV. MAINT COST      0.00   0.16   1.19   3.13   4.21   4.38   4.49   4.62   4.81   4.91   4.89   4.79   4.68   4.57   4.48   4.44

INC STKR PRICE     -0.12  -0.87  -0.80   1.32   2.70  12.20  12.68  15.68  19.89  20.37  21.33  22.12  23.14  23.83  24.79  26.05
PV. STKR PRICE     -0.12  -0.83  -0.74   1.17   2.32  10.03  10.02  11.92  14.54  14.31  14.40  14.37  14.46  14.31  14.31  14.46

INC INVESTMENT     -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0
PV. INVESTMENT     -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

INC  U.S. COST     -0.14  -1.03   0.79  11.01  17.00  26.43  26.81  30.69  37.04  39.14  41.10  42.35  43.63  44.46  45.73  47.51
PV. U.S. COST      -0.14  -1.00   0.73   9.79  14.53  21.73  21.19  23.32  27.06  27.50  27.77  27.50  27.25  26.70  26.41  26.38


           TOTAL COST OF SCENARIO                               INCREMENTAL COST OF SCENARIO

           TOT FUEL  COST         6987.19                       INC FUEL  COST          142.22
           PV. FUEL  COST         5174.84                       PV. FUEL  COST           98.08

           TOT MAINT COST          517.84                       INC MAINT COST           86.04
           PV. MAINT COST          376.43                       PV. MAINT COST           59.75

           TOT STKR PRICE         8007.35                       INC STKR PRICE          224.31
           PV. STKR PRICE         5935.26                       PV. STKR PRICE          148.92

           TOT INVESTMENT            0.0                        INC INVESTMENT            0.0
           PV. INVESTMENT            0.0                        PV. INVESTMENT            0.0

           TOT U.S.  COST        15512.39                       INC U.S.  COST          452.52
           PV. U.S.  COST        11466.52                       PV. U.S.  COST          306.74


                                                                                    COST SUMMARY
                                                                                    NAS  SCENARIO-C'
NAS SCNRO-CS-132 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-138              RUN DATE = 01/21/75


                                         INCREMENTAL COST SUMMARY REPORT

                                           SCALE FACTOR=  1.000D 08

                  1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST     0.00  -0.19   0.59   6.43   9.76   8.77   6.51   3.01  -1.17  -6.32 -12.79 -19.55 -25.69 -31.21 -36.10 -40.33
PV. FUEL COST     0.00  -0.18   0.54   5.71   8.34   7.21   5.15   2.28  -0.86  -4.44  -8.64 -12.70 -16.05 -18.74 -20.85 -22.39

INC MAINT COST    0.00   0.17   1.29   3.55   4.97   5.35   5.65   5.93   6.22   6.40   6.38   6.25   6.13   6.04   5.99   6.02
PV. MAINT COST    0.00   0.17   1.20   3.16   4.25   4.40   4.47   4.51   4.55   4.49   4.31   4.06   3.83   3.62   3.46   3.34

INC STKR PRICE   -0.00  -0.12   0.09  -0.39   2.18   9.59   1.07  -9.63 -16.74 -27.39 -39.99 -45.69 -47.11 -48.69 -50.57 -52.26
PV. STKR PRICE   -0.00  -0.11   0.08  -0.35   1.87   7.88   0.84  -7.32 -12.23 -19.24 -27.02 -29.68 -29.42 -29.24 -29.21 -29.02

INC INVESTMENT   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0
PV. INVESTMENT   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

INC  U.S. COST    0.00  -0.14   1.96   9.59  16.91  23.71  13.22  -0.69 -11.69 -27.32 -46.41 -58.98 -66.68 -73.88 -80.68 -86.58
PV. U.S. COST     0.00  -0.14   1.82   8.52  14.45  19.49  10.45  -0.53  -8.54 -19.19 -31.35 -38.32 -41.65 -44.37 -46.59 -48.07


                  TOTAL COST OF SCENARIO                            INCREMENTAL COST OF SCENARIO

                  TOT FUEL  COST         6706.68                    INC FUEL  COST        -138.29
                  PV. FUEL  COST         5001.13                    PV. FUEL  COST         -75.62

                  TOT MAINT COST          508.15                    INC MAINT COST          76.35
                  PV. MAINT COST          370.48                    PV. MAINT COST          53.80

                  TOT STKR PRICE         7457.39                    INC STKR PRICE        -325.66
                  PV. STKR PRICE         5584.16                    PV. STKR PRICE        -202.17

                  TOT INVESTMENT            0.0                     INC INVESTMENT           0.0
                  PV. INVESTMENT            0.0                     PV. INVESTMENT           0.0

                  TOT U.S.  COST        14672.22                    INC U.S.  COST        -387.64
                  PV. U.S.  COST        10955.78                    PV. U.S.  COST        -224.01


                                                                                                    COST SUMMARY
                                                                                                    NAS  SCENARIO-CS
NAS SCNRIO-E-135 FUDATA-LHL810-059 AGFCTR-DND810-360 SUMPGM-138                    RUN DATE = 09/17/74


                                                    INCREMENTAL COST SUMMARY REPORT

                                                       SCALE FACTOR=  1.00D 08

                   1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST      0.00  -0.20   0.59   6.52   9.89   9.49   9.31  10.29  11.44  12.53  13.45  14.12  14.74  15.35  16.00  16.70
PV. FUEL COST      0.00  -0.19   0.54   5.80   8.45   7.80   7.36   7.82   8.36   8.80   9.08   9.17   9.21   9.22   9.24   9.28

INC MAINT COST     0.00   0.17   1.29   3.55   4.97   5.37   5.71   6.05   6.43   6.73   6.87   6.91   6.94   7.00   7.08   7.24
PV. MAINT COST     0.00   0.17   1.20   3.16   4.25   4.41   4.52   4.60   4.70   4.72   4.64   4.49   4.34   4.20   4.09   4.02

INC STKR PRICE    -0.00  -0.16   0.09   1.96   4.01  12.90  14.20  17.43  18.09  18.65  19.26  19.96  20.63  21.29  22.14  22.82
PV. STKR PRICE    -0.00  -0.14   0.08   1.74   3.44  10.60  11.22  13.24  13.22  13.10  13.01  12.97  12.89  12.79  12.78  12.67

INC INVESTMENT    -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0
PV. INVESTMENT    -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

INC  U.S. COST     0.00  -0.18   1.96  12.04  18.87  27.75  29.22  33.77  35.96  37.89  39.57  41.00  42.32  43.62  45.22  46.75
PV. U.S. COST      0.00  -0.17   1.81  10.70  16.13  22.81  23.10  25.66  26.27  26.62  26.73  26.63  26.43  26.20  26.12  25.96


                   TOTAL COST OF SCENARIO                                   INCREMENTAL COST OF SCENARIO

                   TOT FUEL  COST         7095.20                           INC FUEL  COST          160.22
                   PV. FUEL  COST         5186.69                           PV. FUEL  COST          109.93

                   TOT MAINT COST          514.12                           INC MAINT COST           82.32
                   PV. MAINT COST          374.17                           PV. MAINT COST           57.49

                   TOT STKR PRICE         7996.30                           INC STKR PRICE          213.27
                   PV. STKR PRICE         5929.93                           PV. STKR PRICE          143.59

                   TOT INVESTMENT            0.0                            INC INVESTMENT            0.0
                   PV. INVESTMENT            0.0                            PV. INVESTMENT            0.0

                   TOT U.S.  COST        15515.63                           INC U.S.  COST          455.77
                   PV. U.S.  COST        11490.79                           PV. U.S.  COST          311.01


                                                                                                     COST SUMMARY
                                                                                                     NAS  SCENARIO-E
NAS SCNRO-E-199 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-138                    RUN DATE = 12/21/74

                                             INCREMENTAL COST SUMMARY REPORT

                                                SCALE FACTOR=  1.000D 08

                    1970    1971    1972    1973    1974    1975    1976    1977    1978    1979    1980    1981    1982    1983    1984    1985

INC FUEL COST       0.00   -0.20    0.59    6.52    9.89    9.49    9.42   10.85   12.38   13.83   15.08   16.04   16.94   17.80   18.67   19.57
PV. FUEL COST       0.00   -0.19    0.54    5.80    8.45    7.80    7.45    8.24    9.04    9.72   10.18   10.42   10.58   10.69   10.78   10.87

INC MAINT COST      0.00    0.17    1.29    3.55    4.97    5.37    5.73    6.12    6.55    6.88    7.06    7.15    7.21    7.30    7.42    7.60
PV. MAINT COST      0.00    0.17    1.20    3.16    4.25    4.41    4.53    4.65    4.78    4.83    4.77    4.64    4.51    4.38    4.28    4.22

INC STKR PRICE     -0.00   -0.16    0.09    1.96    4.01   12.90   14.23   17.65   18.14   18.68   19.30   19.97   20.66   21.40   22.14   22.91
PV. STKR PRICE     -0.00   -0.14    0.08    1.74    3.44   10.60   11.24   13.41   13.26   13.13   13.03   12.97   12.91   12.85   12.78   12.72

INC INVESTMENT     -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0
PV. INVESTMENT     -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0

INC  U.S. COST      0.00   -0.18    1.96   12.04   18.87   27.75   29.37   34.61   37.06   39.39   41.43   43.16   44.81   46.49   48.23   50.07
PV. U.S. COST       0.00   -0.17    1.81   10.70   16.13   22.81   23.22   26.30   27.08   27.68   27.99   28.03   27.99   27.92   27.85   27.81


                    TOTAL COST OF SCENARIO                               INCREMENTAL COST OF SCENARIO

                    TOT FUEL  COST        7021.84                        INC FUEL  COST        176.86
                    PV. FUEL  COST        5197.12                        PV. FUEL  COST        120.37

                    TOT MAINT COST         516.18                        INC MAINT COST         84.38
                    PV. MAINT COST         375.46                        PV. MAINT COST         58.78

                    TOT STKR PRICE        7996.91                        INC STKR PRICE        213.87
                    PV. STKR PRICE        5930.34                        PV. STKR PRICE        144.01

                    TOT INVESTMENT           0.0                         INC INVESTMENT          0.0
                    PV. INVESTMENT           0.0                         PV. INVESTMENT          0.0

                    TOT U.S.  COST       15534.93                        INC U.S.  COST        475.06
                    PV. U.S.  COST       11502.92                        PV. U.S.  COST        323.14


                                                                                                  COST SUMMARY
                                                                                                  NAS  SCENARIO-E-2
NAS SCNRO-ED-126 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-138              RUN DATE = 01/21/75

                                         INCREMENTAL COST SUMMARY REPORT

                                             SCALE FACTOR=  1.00D 08

                   1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST      0.00  -0.20   0.59   6.52   9.89   9.49   9.37  10.50  11.32  11.63  11.27  10.32   9.04   7.61   6.41   5.41
PV. FUEL COST      0.00  -0.19   0.54   5.80   8.45   7.80   7.41   7.97   8.27   8.17   7.61   6.70   5.65   4.57   3.70   3.01

INC MAINT COST     0.00   0.17   1.29   3.55   4.97   5.37   5.72   6.08   6.44   6.68   6.73   6.65   6.55   6.45   6.40   6.42
PV. MAINT COST     0.00   0.17   1.20   3.16   4.25   4.41   4.52   4.62   4.70   4.69   4.54   4.32   4.09   3.87   3.69   3.56

INC STKR PRICE    -0.00  -0.16   0.09   1.96   4.01  12.90  14.28  17.86  18.38  18.83  19.50  20.19  20.98  21.76  22.73  23.34
PV. STKR PRICE    -0.00  -0.14   0.08   1.74   3.44  10.60  11.28  13.57  13.43  13.23  13.16  13.12  13.11  13.07  13.13  12.96

INC INVESTMENT    -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0
PV. INVESTMENT    -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

INC  U.S. COST     0.00  -0.18   1.96  12.04  18.87  27.75  29.38  34.43  36.14  37.13  37.48  37.17  36.57  35.81  35.54  35.16
PV. U.S. COST      0.00  -0.17   1.81  10.70  16.13  22.81  23.22  26.16  26.40  26.09  25.32  24.14  22.84  21.51  20.53  19.53


                      TOTAL COST OF SCENARIO                           INCREMENTAL COST OF SCENARIO

                      TOT FUEL  COST       6964.14                     INC FUEL  COST        119.17
                      PV. FUEL  COST       5162.22                     PV. FUEL  COST         85.46

                      TOT MAINT COST        511.27                     INC MAINT COST         79.47
                      PV. MAINT COST        372.48                     PV. MAINT COST         55.80

                      TOT STKR PRICE       7999.70                     INC STKR PRICE        216.66
                      PV. STKR PRICE       5932.11                     PV. STKR PRICE        145.77

                      TOT INVESTMENT          0.0                      INC INVESTMENT          0.0
                      PV. INVESTMENT          0.0                      PV. INVESTMENT          0.0

                      TOT U.S.  COST      15475.12                     INC U.S.  COST        415.25
                      PV. U.S.  COST      11466.81                     PV. U.S.  COST        287.02

                                                                                        COST SUMMARY
                                                                                        NAS  SCENARIO-ED
NAS SCNRO-ED-201 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-138             RUN DATE = 12/21/74


                                        INCREMENTAL COST SUMMARY REPORT

                                           SCALE FACTOR=  1.000 08

                   1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST      0.00  -0.20   0.59   6.52   9.89   9.49   9.29  10.06  10.53  10.50   9.85   8.65   7.17   5.56   4.21   3.08
PV. FUEL COST      0.00  -0.19   0.54   5.80   8.45   7.80   7.35   7.64   7.69   7.38   6.65   5.62   4.48   3.34   2.43   1.71

INC MAINT COST     0.00   0.17   1.29   3.55   4.97   5.37   5.71   6.04   6.38   6.59   6.62   6.53   6.40   6.29   6.22   6.24
PV. MAINT COST     0.00   0.17   1.20   3.16   4.25   4.41   4.52   4.59   4.66   4.63   4.47   4.24   4.00   3.77   3.59   3.46

INC STKR PRICE    -0.00  -0.16   0.09   1.96   4.01  12.90  14.18  17.39  17.87  18.28  18.97  19.64  20.43  21.20  22.12  22.76
PV. STKR PRICE    -0.00  -0.14   0.08   1.74   3.44  10.60  11.20  13.21  13.06  12.85  12.81  12.76  12.76  12.73  12.77  12.63

INC INVESTMENT    -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0
PV. INVESTMENT    -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

INC  U.S. COST     0.00  -0.18   1.96  12.04  18.87  27.75  29.18  33.49  34.78  35.37  35.43  34.83  34.00  33.04  32.55  32.06
PV. U.S. COST      0.00  -0.17   1.81  10.70  16.13  22.81  23.07  25.44  25.41  24.85  23.93  22.62  21.23  19.85  18.80  17.81


                 TOTAL COST OF SCENARIO                             INCREMENTAL COST OF SCENARIO

                 TOT FUEL  COST       6950.16                       INC FUEL  COST        105.18
                 PV. FUEL  COST       5153.44                       PV. FUEL  COST         76.68

                 TOT MAINT COST        510.19                       INC MAINT COST         78.39
                 PV. MAINT COST        371.81                       PV. MAINT COST         55.13

                 TOT STKR PRICE       7994.68                       INC STKR PRICE        211.63
                 PV. STKR PRICE       5928.83                       PV. STKR PRICE        142.50

                 TOT INVESTMENT          0.0                        INC INVESTMENT          0.0
                 PV. INVESTMENT          0.0                        PV. INVESTMENT          0.0

                 TOT U.S.  COST      15455.03                       INC U.S.  COST        395.17
                 PV. U.S.  COST      11454.08                       PV. U.S.  COST        274.29


                                                                                              COST SUMMARY
                                                                                              NAS  SCENARIO-ED-2
NAS SCNRO-ES-128 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-138              RUN DATE = 01/21/75


                                              INCREMENTAL COST SUMMARY REPORT

                                                SCALE FACTOR=  1.000D 08

                    1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST       0.00  -0.20   0.59   6.52   9.89   9.49   9.42  10.59  11.12  10.92   9.89   8.09   6.01   3.68   1.33  -0.94
PV. FUEL COST       0.00  -0.19   0.54   5.80   8.45   7.80   7.45   8.04   8.13   7.67   6.67   5.25   3.75   2.21   0.77  -0.52

INC MAINT COST      0.00   0.17   1.29   3.55   4.97   5.37   5.73   6.12   6.60   7.01   7.28   7.44   7.59   7.76   7.96   8.22
PV. MAINT COST      0.00   0.17   1.20   3.16   4.25   4.41   4.53   4.66   4.82   4.92   4.91   4.83   4.74   4.66   4.60   4.57

INC STKR PRICE     -0.00  -0.16   0.09   1.96   4.01  12.90  14.23  17.24  17.98  18.81  19.57  20.48  21.35  22.09  23.16  23.98
PV. STKR PRICE     -0.00  -0.14   0.08   1.74   3.44  10.60  11.24  13.10  13.14  13.22  13.22  13.31  13.34  13.26  13.37  13.31

INC INVESTMENT     -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0
PV. INVESTMENT     -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

INC U.S. COST       0.00  -0.18   1.96  12.04  18.87  27.75  29.37  33.96  35.70  36.73  36.72  36.02  34.95  33.52  32.45  31.26
PV. U.S. COST       0.00  -0.17   1.81  10.70  16.13  22.81  23.22  25.80  26.08  25.81  24.80  23.39  21.83  20.14  18.74  17.36



                    TOTAL COST OF SCENARIO                               INCREMENTAL COST OF SCENARIO

                    TOT FUEL  COST        6941.36                        INC FUEL  COST          96.39
                    PV. FUEL  COST        5148.58                        PV. FUEL  COST          71.82

                    TOT MAINT COST         518.87                        INC MAINT COST          87.07
                    PV. MAINT COST         377.10                        PV. MAINT COST          60.42

                    TOT STKR PRICE        8000.75                        INC STKR PRICE         217.70
                    PV. STKR PRICE        5932.56                        PV. STKR PRICE         146.23

                    TOT INVESTMENT           0.0                         INC INVESTMENT           0.0
                    PV. INVESTMENT           0.0                         PV. INVESTMENT           0.0

                    TOT U.S.  COST       15460.98                        INC U.S.  COST         401.12
                    PV. U.S.  COST       11458.24                        PV. U.S.  COST         278.46


                                                                                                   COST SUMMARY
                                                                                                   NAS  SCENARIO-ES
NAS SCNRO-ES-200 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-138            RUN DATE = 12/21/74

                                              INCREMENTAL COST SUMMARY REPORT

                                                   SCALE FACTOR=  1.000 08

                  1970    1971    1972    1973    1974    1975    1976    1977    1978    1979    1980    1981    1982    1983    1984    1985

INC FUEL COST     0.00   -0.20    0.59    6.52    9.89    9.49    9.42   10.74   11.83   12.59   12.91   12.81   12.58   12.25   11.92   11.67
PV. FUEL COST     0.00   -0.19    0.54    5.80    8.45    7.80    7.45    8.16    8.65    8.85    8.72    8.32    7.86    7.36    6.88    6.48

INC MAINT COST    0.00    0.17    1.29    3.55    4.97    5.37    5.73    6.14    6.70    7.25    7.72    8.13    8.55    9.02    9.53   10.09
PV. MAINT COST    0.00    0.17    1.20    3.16    4.25    4.41    4.53    4.67    4.89    5.09    5.21    5.28    5.34    5.41    5.50    5.61

INC STKR PRICE   -0.00   -0.16    0.09    1.96    4.01   12.90   14.23   17.46   17.79   18.24   18.75   19.37   20.02   20.70   21.41   22.19
PV. STKR PRICE   -0.00   -0.14    0.08    1.74    3.44   10.60   11.24   13.27   13.00   12.82   12.66   12.58   12.51   12.43   12.36   12.31

INC INVESTMENT   -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0
PV. INVESTMENT   -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0

INC  U.S. COST    0.00   -0.18    1.96   12.04   18.87   27.75   29.37   34.35   36.32   38.08   39.37   40.31   41.14   41.96   42.86   43.94
PV. U.S. COST     0.00   -0.17    1.81   10.70   16.13   22.81   23.22   26.09   26.54   26.76   26.60   26.18   25.70   25.21   24.75   24.40


                   TOTAL COST OF SCENARIO                           INCREMENTAL COST OF SCENARIO

                   TOT FUEL  COST      6989.98                      INC FUEL  COST      145.01
                   PV. FUEL  COST      5177.87                      PV. FUEL  COST      101.11

                   TOT MAINT COST       526.03                      INC MAINT COST       94.23
                   PV. MAINT COST       381.40                      PV. MAINT COST       64.72

                   TOT STKR PRICE      7992.00                      INC STKR PRICE      208.96
                   PV. STKR PRICE      5927.23                      PV. STKR PRICE      140.90

                   TOT INVESTMENT        0.0                        INC INVESTMENT        0.0
                   PV. INVESTMENT        0.0                        PV. INVESTMENT        0.0

                   TOT U.S.  COST     15508.02                      INC U.S.  COST      448.15
                   PV. U.S.  COST     11486.50                      PV. U.S.  COST      396.73

                                                                                          COST SUMMARY
                                                                                          NAS  SCENARIO-ES-2
NAS SCNRO-EW-127 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-138                RUN DATE = 01/21/75


                                               INCREMENTAL COST SUMMARY REPORT

                                                 SCALE FACTOR=  1.000 08

                      1970    1971    1972    1973    1974    1975    1976    1977    1978    1979    1980    1981    1982    1983    1984    1985

INC FUEL COST         0.00   -0.20    0.59    6.52    9.89    9.49    9.43   10.83   12.38   13.96   15.42   16.70   18.00   19.32   20.63   21.91
PV. FUEL COST         0.00   -0.19    0.54    5.80    8.45    7.80    7.46    8.23    9.05    9.81   10.42   10.85   11.25   11.61   11.91   12.17

INC MAINT COST        0.00    0.17    1.29    3.55    4.97    5.37    5.72    6.10    6.53    6.88    7.08    7.20    7.32    7.47    7.64    7.87
PV. MAINT COST        0.00    0.17    1.20    3.16    4.25    4.41    4.53    4.64    4.77    4.83    4.79    4.68    4.58    4.48    4.41    4.37

INC STKR PRICE       -0.00   -0.16    0.09    1.96    4.01   12.87   14.10   17.30   17.11   16.64   16.19   15.68   15.21   14.98   15.58   16.09
PV. STKR PRICE       -0.00   -0.14    0.08    1.74    3.44   10.58   11.14   13.15   12.51   11.69   10.93   10.19    9.50    8.99    8.99    8.93

INC INVESTMENT       -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0
PV. INVESTMENT       -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0    -0.0

INC  U.S. COST        0.00   -0.18    1.96   12.04   18.87   27.73   29.25   34.24   36.03   37.47   38.69   39.59   40.53   41.76   43.84   45.87
PV. U.S. COST         0.00   -0.17    1.81   10.70   16.13   22.79   23.12   26.01   26.32   26.33   26.13   25.72   25.31   25.08   25.32   25.47


                  TOTAL COST OF SCENARIC                                   INCREMENTAL COST OF SCENARIO

                  TOT FUEL  COST         7029.87                           INC FUEL  COST          184.90
                  PV. FUEL  COST         5201.90                           PV. FUEL  COST          125.14

                  TOT MAINT COST          516.99                           INC MAINT COST           85.19
                  PV. MAINT COST          375.93                           PV. MAINT COST           59.25

                  TOT STKR PRICE         7960.70                           INC STKR PRICE          177.66
                  PV. STKR PRICE         5908.05                           PV. STKR PRICE          121.72

                  TOT INVESTMENT            0.0                            INC INVESTMENT            0.0
                  PV. INVESTMENT            0.0                            PV. INVESTMENT            0.0

                  TOT U.S.  COST        15507.57                           INC U.S.  COST          447.70
                  PV. U.S.  COST        11485.89                           PV. U.S.  COST          306.10


                                                                                                           COST SUMMARY
                                                                                                           NAS  SCENARIO-EW
NAS SCNRIO-F1-129 FDATA-CHE310-059 AGFCTR-GDC810-060 SUMPGM-139          RUN DATE = 09/17/74


                                   INCREMENTAL COST SUMMARY REPORT

                                        SCALE FACTOR=  1.000 08

                 1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST    0.00  -0.20   0.59   6.52   9.89   9.49   9.31  10.16  10.62  10.66  10.18   9.23   8.09   6.86   5.72   4.77
PV. FUEL COST    0.00  -0.19   0.54   5.80   8.45   7.80   7.36   7.72   7.76   7.49   6.87   5.99   5.06   4.12   3.30   2.65

INC MAINT COST   0.00   0.17   1.29   3.55   4.97   5.37   5.71   6.10   6.66   7.06   7.23   7.24   7.21   7.17   7.17   7.23
PV. MAINT COST   0.00   0.17   1.20   3.16   4.25   4.41   4.52   4.64   4.87   4.95   4.88   4.71   4.51   4.30   4.14   4.01

INC STKR PRICE  -0.00  -0.15   0.09   1.96   4.01  12.90  14.20  18.93  24.19  24.86  25.59  26.55  27.41  28.29  29.20  30.06
PV. STKR PRICE  -0.00  -0.14   0.08   1.74   3.44  10.60  11.22  14.38  17.68  17.47  17.28  17.25  17.12  16.99  16.86  16.69

INC INVESTMENT   0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0
PV. INVESTMENT   0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0

INC  U.S. COST   0.00  -0.18   1.96  12.03  18.87  27.75  29.22  35.19  41.47  42.57  42.99  43.03  42.71  42.31  42.09  42.05
PV. U.S. COST    0.00  -0.17   1.81  10.70  16.13  22.81  23.10  26.74  30.30  29.91  29.04  27.95  26.67  25.41  24.31  23.35


                  TOTAL COST OF SCENARIO                          INCREMENTAL COST OF SCENARIO

                  TOT FUEL  COST        6956.86                   INC FUEL  COST         111.89
                  PV. FUEL  COST        5157.64                   PV. FUEL  COST          80.72

                  TOT MAINT COST         515.95                   INC MAINT COST          84.15
                  PV. MAINT COST         375.29                   PV. MAINT COST          58.71

                  TOT STKR PRICE        8351.13                   INC STKR PRICE         268.08
                  PV. STKR PRICE        5964.93                   PV. STKR PRICE         178.65

                  TOT INVESTMENT           0.0                    INC INVESTMENT           0.0
                  PV. INVESTMENT           0.0                    PV. INVESTMENT           0.0

                  TOT U.S.  COST       15823.95                   INC U.S.  COST         464.08
                  PV. U.S.  COST       11497.86                   PV. U.S.  COST         318.07


                                                                                                  COST SUMMARY
                                                                                                  NAS  SCENARIO-F1
NAS SCNRO-I-124 FUDATA-LHL010-059 AGFCTR-DND810-060 SUMPGM-138              RUN DATE = 01/21/75

                                                  INCREMENTAL COST SUMMARY REPORT

                                                     SCALE FACTOR=  1.000 04

                   1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST      0.00  -0.20   0.59   6.52   9.89   9.91  12.23  17.24  21.19  24.03  25.86  26.92  27.60  28.21  28.83  29.38

PV. FUEL COST      0.00  -0.19   0.54   5.80   8.45   8.15   9.67  13.10  15.48  16.88  17.47  17.49  17.24  16.95  16.65  16.32

INC MAINT COST     0.00   0.17   1.29   3.55   4.97   5.37   5.76   6.33   6.90   7.34   7.60   7.75   7.88   8.02   8.18   8.40

PV. MAINT COST     0.00   0.17   1.20   3.16   4.25   4.41   4.55   4.81   5.04   5.15   5.14   5.04   4.92   4.81   4.72   4.66

INC STKR PPICE    -0.00  -0.16   0.09   1.96   4.01  13.72  20.56  31.15  32.21  33.38  34.67  35.99  37.38  38.54  40.23  41.34

PV. STKR PRICE    -0.00  -0.14   0.08   1.74   3.44  11.28  16.25  23.67  23.54  23.46  23.41  23.38  23.35  23.14  23.23  22.95

INC INVESTMENT    -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

PV. INVESTMENT    -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

INC  U.S. COST     0.00  -0.18   1.96  12.04  18.87  29.00  38.55  54.72  60.29  64.75  68.12  70.68  72.86  74.76  77.24  79.10

PV. U.S. COST      0.00  -0.17   1.81  10.70  16.13  23.84  30.47  41.58  44.05  45.49  46.02  45.91  45.51  44.90  44.61  43.93


                  TOTAL COST OF SCENARIO                                INCREMENTAL COST OF SCENARIO

                  TOT FUEL  COST        7113.18                         INC FUEL  COST         268.21
                  PV. FUEL  COST        5256.74                         PV. FUEL  COST         179.98

                  TOT MAINT COST         521.31                         INC MAINT COST          89.51
                  PV. MAINT COST         378.71                         PV. MAINT COST          62.03

                  TOT STKR PRICE        8148.12                         INC STKR PRICE         365.09
                  PV. STKR PRICE        6029.11                         PV. STKR PRICE         242.78

                  TOT INVESTMENT           0.0                          INC INVESTMENT           0.0
                  PV. INVESTMENT           0.0                          PV. INVESTMENT           0.0

                  TOT U.S.  COST       15782.63                         INC U.S.  COST         722.77
                  PV. U.S.  COST       11664.56                         PV. U.S.  COST         484.78

                                                                                                      COST SUMMARY
                                                                                                      NAS  SCENARIO-I
NAS SCNRO-J-125 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-138                RUN DATE = 01/21/75


                                              INCREMENTAL COST SUMMARY REPORT

                                                 SCALE FACTOR=  1.000 08

                  1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST     0.00  -0.20   0.59   6.52   9.89   9.49   9.40  11.77  16.97  21.03  23.86  25.69  26.91  27.72  28.60  29.41
PV. FUEL COST     0.00  -0.19   0.54   5.80   8.45   7.80   7.43   8.94  12.40  14.77  16.11  16.68  16.81  16.65  16.51  16.33

INC MAINT COST    0.00   0.17   1.29   3.55   4.97   5.37   5.72   6.15   6.76   7.24   7.53   7.70   7.84   7.98   8.16   8.39
PV. MAINT COST    0.00   0.17   1.20   3.16   4.25   4.41   4.53   4.67   4.94   5.08   5.09   5.00   4.90   4.79   4.71   4.66

INC STKR PRICE   -0.00  -0.16   0.09   1.96   4.01  12.90  14.28  21.16  32.12  33.16  34.47  35.91  37.29  38.54  40.23  41.34
PV. STKR PRICE   -0.00  -0.14   0.08   1.74   3.44  10.60  11.28  16.08  23.47  23.30  23.28  23.33  23.29  23.14  23.23  22.95

INC INVESTMENT   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0
PV. INVESTMENT   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

INC  U.S. COST    0.00  -0.18   1.96  12.04  18.87  27.75  29.41  39.08  55.85  61.42  65.85  69.30  72.03  74.23  76.99  79.12
PV. U.S. COST     0.00  -0.17   1.81  10.70  16.13  22.81  23.24  29.69  40.81  43.15  44.49  45.01  44.99  44.58  44.46  43.94


                      TOTAL COST OF SCENARIO                                    INCREMENTAL COST OF SCENARIO

                      TOT FUEL  COST          7092.61                           INC FUEL  COST          247.63
                      PV. FUEL  COST          5241.80                           PV. FUEL  COST          165.04

                      TOT MAINT COST           520.63                           INC MAINT COST           88.83
                      PV. MAINT COST           378.23                           PV. MAINT COST           61.55

                      TOT STKR PRICE          8130.35                           INC STKR PRICE          347.31
                      PV. STKR PRICE          6015.42                           PV. STKR PRICE          229.08

                      TOT INVESTMENT            0.0                             INC INVESTMENT            0.0
                      PV. INVESTMENT            0.0                             PV. INVESTMENT            0.0

                      TOT U.S.  COST         15743.59                           INC U.S.  COST          683.73
                      PV. U.S.  COST         11635.44                           PV. U.S.  COST          455.66


                                                                                                        COST SUMMARY
                                                                                                        NAS  SCENARIO-J
NAS SCNRO-JS-133 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-138              RUN DATE = 01/21/75

                                        INCREMENTAL COST SUMMARY REPORT

                                          SCALE FACTOR=  1.000 08

                   1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST      0.00  -0.19   0.59   6.43   9.76   8.77   7.00   6.45   7.12   5.61   1.58  -3.50  -8.42 -13.05 -17.13 -20.75
PV. FUEL COST      0.00  -0.18   0.54   5.71   8.34   7.21   5.54   4.90   5.20   3.94   1.07  -2.27  -5.26  -7.83  -9.89 -11.52

INC MAINT COST     0.00   0.17   1.29   3.55   4.97   5.35   5.64   5.90   6.25   6.43   6.34   6.11   5.88   5.69   5.55   5.50
PV. MAINT COST     0.00   0.17   1.20   3.16   4.25   4.40   4.46   4.48   4.57   4.51   4.28   3.97   3.68   3.41   3.20   3.05

INC STKR PRICE    -0.00  -0.12   0.09  -0.39   2.18   9.59   2.10  -1.66   1.35  -8.27 -20.06 -24.71 -25.28 -25.98 -26.98 -27.98
PV. STKR PRICE    -0.00  -0.11   0.08  -0.35   1.87   7.88   1.66  -1.26   0.99  -5.81 -13.56 -16.05 -15.78 -15.60 -15.58 -15.54

INC INVESTMENT    -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0
PV. INVESTMENT    -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

INC  U.S. COST     0.00  -0.14   1.96   9.59  16.91  23.71  14.74  10.69  14.73   3.76 -12.15 -22.09 -27.82 -33.34 -38.56 -43.24
PV. U.S. COST      0.00  -0.14   1.82   8.52  14.45  19.49  11.65   8.12  10.76   2.64  -8.21 -14.35 -17.38 -20.02 -22.26 -24.01


              TOTAL COST OF SCENARIO                              INCREMENTAL COST OF SCENARIO

              TOT FUEL  COST          6835.25                     INC FUEL  COST          -9.72
              PV. FUEL  COST          5082.25                     PV. FUEL  COST           5.49

              TOT MAINT COST           506.43                     INC MAINT COST          74.63
              PV. MAINT COST           369.47                     PV. MAINT COST          52.79

              TOT STKR PRICE          7636.93                     INC STKR PRICE        -146.11
              PV. STKR PRICE          5699.16                     PV. STKR PRICE         -87.17

              TOT INVESTMENT             0.0                      INC INVESTMENT           0.0
              PV. INVESTMENT             0.0                      PV. INVESTMENT           0.0

              TOT U.S.  COST         14978.62                     INC U.S.  COST         -81.25
              PV. U.S.  COST         11150.88                     PV. U.S.  COST         -28.91


                                                                                             COST SUMMARY
                                                                                             NAS  SCENARIO-JS
NAS SCNRO-K-130 FUDATA-LHL810-059 AGFCTR-DND810-060 SUMPGM-138                RUN DATE = 01/21/75

                                         INCREMENTAL COST SUMMARY REPORT

                                              SCALE FACTOR=  1.000 08

                  1970   1971   1972   1973   1974   1975   1976   1977   1978   1979   1980   1981   1982   1983   1984   1985

INC FUEL COST     0.00  -0.20   0.59   6.52   9.89   9.49   9.38  10.60  11.86  13.57  16.72  18.99  20.51  21.45  22.44  23.43
PV. FUEL COST     0.00  -0.19   0.54   5.80   8.45   7.80   7.42   8.05   8.67   9.54  11.29  12.34  12.81  12.89  12.96  13.01

INC MAINT COST    0.00   0.17   1.29   3.55   4.97   5.37   5.72   6.08   6.47   6.81   7.10   7.27   7.39   7.51   7.66   7.87
PV. MAINT COST    0.00   0.17   1.20   3.16   4.25   4.41   4.52   4.62   4.72   4.78   4.79   4.72   4.62   4.50   4.42   4.37

INC STKR PRICE   -0.00  -0.16   0.09   1.96   4.01  12.90  14.69  19.86  21.83  26.31  35.02  36.60  38.05  39.47  41.25  42.42
PV. STKR PRICE   -0.00  -0.14   0.08   1.74   3.44  10.60  11.61  15.09  15.95  18.49  23.65  23.78  23.77  23.70  23.82  23.55

INC INVESTMENT   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0
PV. INVESTMENT   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0   -0.0

INC  U.S. COST    0.00  -0.18   1.96  12.04  18.87  27.75  29.79  36.54  40.16  46.69  58.83  62.86  65.95  68.42  71.35  73.71
PV. U.S. COST     0.00  -0.17   1.81  10.73  16.13  22.81  23.55  27.76  29.34  32.80  39.74  40.83  41.19  41.09  41.21  40.93


                    TOTAL COST OF SCENARIO                              INCREMENTAL COST OF SCENARIO

                    TOT FUEL  COST       7040.23                        INC FUEL  COST        195.26
                    PV. FUEL  COST       5208.12                        PV. FUEL  COST        131.37

                    TOT MAINT COST        517.02                        INC MAINT COST         85.22
                    PV. MAINT COST        375.93                        PV. MAINT COST         59.25

                    TOT STKR PRICE       8117.34                        INC STKR PRICE        334.30
                    PV. STKR PRICE       6005.46                        PV. STKR PRICE        219.12

                    TOT INVESTMENT          0.0                         INC INVESTMENT          0.0
                    PV. INVESTMENT          0.0                         PV. INVESTMENT          0.0

                    TOT U.S.  COST      15674.60                        INC U.S.  COST        614.73
                    PV. U.S.  COST      11589.52                        PV. U.S.  COST        409.73

                                                                                                       COST SUMMARY
                                                                                                       NAS  SCENARIO-K
```

U.S. GOVERNMENT PRINTING OFFICE: 1975— 582-419:223